ISSN 1831-9424

European Commission

Sustainable public procurement: current status and environmental impacts

Knowledge to support policymaking

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2024

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EUR 31655

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JRC134432

EUR 31655

Print	ISBN 978-92-68-07464-0	ISSN 1018-5593	doi:10.2760/222	KJ-NA-31-655-EN-C
PDF	ISBN 978-92-68-07465-7	ISSN 1831-9424	doi:10.2760/06145	KJ-NA-31-655-EN-N

Luxembourg: Publications Office of the European Union, 2024

How to cite this report: European Commission, Joint Research Centre, Sanye Mengual, E., Valenzano, A., Sinkko, T., Garcia Herrero, L., Casonato, C., Listorti, G. and Sala, S., *Sustainable public procurement: current status and environmental impacts*, Publications Office of the European Union, Luxembourg, 2024, https://data.europa.eu/doi/10.2760/06145, JRC134432.

Contents

Abstract

The current challenges affecting the EU food system call for an urgent shift towards more sustainability. In this context, voluntary Green public procurement criteria (GPP), referring to the environmental dimension, exist at EU level since 2008. Sustainable public procurement (SPP) could play a key role in shaping production and consumption trends by coherently integrating the economic, environmental and social sustainability dimensions.

This report analyses the current uptake of voluntary GPP criteria (including national implementation) and their environmental impact, and considers the potential environmental impact of possible SPP measures.

Available data show that there is a positive, but very heterogeneous, trend in GPP uptake in the EU. Current GPP criteria address all environmental impacts, although focused on climate change and biodiversity loss. Being voluntary, the effectiveness of the GPP measures put in place is hard to estimate as public authorities are free to set the thresholds for each criteria. Findings from literature show that countries and municipalities strongly support purchasing organic and certified products, food waste reduction measures and plant-based menus in catering. SPP criteria would provide environmental benefits resulting from a wider uptake of environmental criteria together with the promotion of plant-based diets.

Acknowledgements

The authors of the report want to thank for their precious support and exchange with JRC colleagues Miguel Gama Caldas (JRC.B5), Joao Leite, Sandra Caldeira and Jan Wollgast (JRC.F1). As well, we would like to acknowledge the inputs from Angelina Frankowska (JRC.D3) to the modelling of dietary changes.

The authors are solely responsible for the content of the report. The views expressed are purely those of the authors and may not in any circumstances be regarded as stating an official position of the European Commission.

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1 Introduction

This Chapter introduces the policy context and background (Section 1.1) as well as green and sustainable public procurement measures (Section 1.2).

1.1 Policy context and background

The Farm to Fork Strategy[1] (F2F Strategy; (European Commission. (2020)), adopted in May 2020 by the European Commission, aims at comprehensively addressing the challenges of sustainable food systems. The F2F Strategy recognises the inextricable links between healthy people, healthy societies and a healthy planet. All citizens and operators across value chains, in the EU and elsewhere, should benefit from a just transition. This strategy is also central to the Commission's European Green Deal[2] and wider agenda to achieve the United Nations' Sustainable Development Goals (SDGs) [3].

The F2F Strategy indicates that a system approach is needed. It recognises that the food system is characterized by strong interrelations between supply chains, consumption patterns, ecosystems, our health, and planetary boundaries. It also sets a direction of travel bringing together various sectoral policies that affect food production, processing, distribution and consumption, and refocusing all action on the transition to sustainability, to move towards a fair, healthy and environmentally-friendly food system. A transition to a sustainable food system thus requires a shift in perspective and a recognition of the interlinkages among different elements, dimensions, and related policies. This also poses complex methodological challenges to the analysis, which will need to cover the different sectors, actors and sustainability dimensions involved.

The environmental dimension has a central role in the Strategy. The stated EU's goals are to 'reduce the environmental and climate footprint of the EU food system and strengthen its resilience, ensure food security in the face of climate change and biodiversity loss and lead a global transition towards competitive sustainability from farm to fork and tapping into new opportunities' (European Commission, 2020a)). The Strategy further notes that ensuring that the whole food chain has a neutral or positive environmental impact requires the adoption of a comprehensive perspective, 'preserving and restoring the land, freshwater and sea-based resources on which the food system depends; helping to mitigate climate change and adapting to its impacts; protecting land, soil, water, air, plant and animal health and welfare; and reversing the loss of biodiversity'.

At the EU level, the Science Advice for Policy by European Academies (SAPEA) embraces a vision of long-term sustainability for the European food system. Food security should be ensured together with conservation of ecosystems and their services, social acceptability and inclusivity, and economic dynamism. The SAPEA report (SAPEA, 2020) also highlights two hot spots of the EU food system: i) the availability of nutritious and healthy food should not come at the environmental and social expense of people and territories outside the EU; ii) the need to address the diversity of the EU's farming sector and territorial imbalances between urban and rural areas. The recent EEA report (EEA, 2023), while analysing EU policies for a European sustainable food system, points out also at the need for policy measures that can drive the phasing out of harmful practices and phasing in of those stimulating more sustainable innovation. Furthermore, it is fundamental to engage stakeholders at national, regional and municipal levels in supporting strategies that are aligned with Europe's sustainability goals and reflect local contexts.

Within this context, the present report aims to contribute to the analysis of sustainability transition by providing further insights on the environmental dimension of Green Public Procurement (GPP). The report focuses on the environmental impacts of GPP criteria for food procurement, catering services

[1] https://food.ec.europa.eu/horizontal-topics/farm-fork-strategy_en
[2] https://commission.europa.eu/publications/communication-european-green-deal_en
[3] https://sdgs.un.org/goals

and vending machines, mapping them to the different stages of the food chain and providing an analysis of the implementations which are currently in place.

Our analysis also aims at contributing to sound evidence informed policymaking. As stated by the better regulation guidelines and associated toolbox (the main Commission regulatory framework; European Commission, 2021a), political decisions should indeed be informed by the best available evidence throughout the policy cycle. In this context, our findings are relevant in various respects. The analysis was completed in summer 2023 and includes an evaluation of sustainability labels launched in the market during the year 2021.

First, as the actual objectives of the analysis are related to a key policy question. Climate change and environmental degradation are an existential threat to Europe and the world; the Farm to Fork Strategy is at the heart of the European Green Deal that strives to transform the EU into a modern, resource-efficient and competitive economy.

Second, from a methodological perspective, the complexity of the policy issue at stake implies a number of challenges. Integrated, systemic perspectives are needed that account for all sustainability dimensions (economic, environmental, social including health) across all stages in the food system, taking into account all relevant actors involved as well different policy sectors. Having in mind the complexity of the systems and the interdisciplinary analysis needed, an appropriate methodological mix has to be designed, relying on qualitative as well quantitative methods, backed up by desk research and expert advice.

Third, our analysis builds a comprehensive picture which is available to inform reflection on the definition of the policy issues at stake. Better regulation recommends integrating the evidence base to inform the decisions of the policymakers already from early stages of the process (European Commission, 2021a). This remains one of its most key and challenging elements.

Last but not least, the present exercise aims at contributing to the debate on the improvement of regulatory quality. The better regulation policy is recognized as a step forward towards a sound use of evidence for all policymaking activities, by providing extensive practical guidance. In the academic debate on the better regulation agenda (for a review see (Listorti et al., 2019) scholars call for transparency on data, assumptions and methodology, and for a balanced implementation of qualitative and quantitative methods. The present analysis can be regarded as a concrete example of designing a pragmatic but sound methodology to address key policy issues. In addition, most interestingly, the very debate on the better regulation often seems to be confined within the academic fields of political science, public administration, and law. In practice, scientists from many other scientific fields are often deeply involved in better regulation related activities that is in providing evidence in support to policy - such as the environmental scientists carrying out analysis of ex ante impact assessment, policy implementation, ex post policy evaluation. This research can also contribute to bridging the gap between different scientific communities which are involved in promoting evidence informed policymaking. The inclusion of such missing perspectives is of crucial importance for learning and further improvement of regulation quality.

1.2 Green and sustainable public procurement

1.2.1 Public Procurement at EU level

Every year, over 250 000 public authorities in the EU spend around 14% of GDP (around €2 trillion per year) on the purchase of goods, services and works[4]. Public procurement, thanks to the volume and market power of public purchases, has the potential to shape production and consumption trends. This capacity of public procurement to create demand and shape the market has been acknowledged

[4] https://single-market-economy.ec.europa.eu/single-market/public-procurement_en

in several previous European policy lines, like, for instance, the communication from the Commission on public procurement for a better environment COM(2008)400[5], the communication from the Commission making public procurement work in and for Europe COM(2017)572, the Commission notice on Guidance on Innovation Procurement C(2021) 4320 and finally the proposal for a regulation on establishing a framework for setting ecodesign requirements for sustainable products COM(2022)142[6]. The power that public procurement has to shape the market could be effectively summoned to help induce a significant transformation in the European food system.

Concerning the European food system, the overall value of the 'Food and Beverage Service Activities' sector in the EU reached 390 billion EUR in 2019 (total production value; Eurostat). Data gathered from Eurostat allow estimating that around 60% of the value of the foodservice is linked to the cost of food items, therefore, the total amount of food items value purchased by the public sector each year can be estimated at around 33 billion EUR[7]. This value, being around 5,2% of the grand total of 633 billion EUR that annually is spent on food in the EU, can allow for meaningful action in the European food system.

In 2003, the European Commission in its Communication on Integrated Product Policy COM (2003) 302, encouraged Member States to draw up publicly available National Action Plans (NAPs) for greening their public procurement. The NAPs, which are not legally-binding, should contain an assessment of the existing situation and ambitious targets for the next three years[8], specifying what measures will be taken to achieve them[9].

The report from Best-ReMaP[10] from 2021 provides useful information on the current state of Public Food Procurement (PFP) in nine Member States and on how legislation works in the different countries. In Austria, Belgium, Finland, Greece and Poland the competences for PFP are distributed between many stakeholders (national, regional or local level). In Bulgaria, Hungary and Slovenia, PFP is managed at national level. Denmark has a municipality level management and procedures of PFP depend on the section or department responsible for the tender. In these countries there are already provisions, guidelines, standards or recommendations that are often not mandatory to follow, making the PFP very inconsistent and heterogeneous across regions.

1.2.2 Green public procurement

Green public procurement (GPP) is defined as "...a process whereby public authorities seek to procure goods, services and works with a reduced environmental impact throughout their life cycle when compared to goods, services and works with the same primary function that would otherwise be procured" (European Commission, 2008).[11] In 2008, the European Commission set a voluntary target

[5] https://ec.europa.eu/transparency/documents-register/detail?ref=COM(2008)400&lang=en

[6] https://eur-lex.europa.eu/legal-content/EN/ALL/?uri=CELEX%3A52022PC0142

[7] The public sector is estimated to be worth around 55 billion EUR, while the purchase of food items by the public sector is estimated to be 33 billion EUR.

[8] As per the COM(2003) 302 final, Member States are encouraged by the European Commission to "draw up publicly available action plans for greening their public procurement. These should contain an assessment of the existing situation and ambitious targets for the situation in three years time. The action plans should also state clearly what measures will be taken to achieve this." Also, "Member States should submit report on progress to the Commission every three years".

[9] https://ec.europa.eu/environment/gpp/action_plan_en.htm

[10] https://bestremap.eu/wp-content/uploads/2022/08/D7.1-Overview-applicative-situation-analyses-of-the-existing-EU-and-national-legislation.pdf

[11] The terms sustainable criteria and green criteria are often used interchangeably, and this is incorrect, especially because green procurement doesn't necessarily lead to more sustainable procurement practices (Smith et al., 2016)

that, by 2010, 50% of all public tendering procedures should be compliant with endorsed common core EU GPP criteria[12].

Being a voluntary instrument, Member States are allowed to decide to which extent they will implement GPP criteria and ambitions (thresholds). GPP criteria have been developed to support public authorities to purchase goods and services with lower environmental impacts compared to the average situation in the market[13]. The basic concept of GPP criteria relies on having clear, verifiable, justifiable and ambitious environmental criteria for products and services, based on a life-cycle approach and scientific evidence base. In the Communication "Public procurement for a better environment" (COM (2008) 400) the Commission recommended the creation of a process for setting common GPP criteria. The criteria used by Member States should be similar to avoid a distortion of the single market and a reduction of EU-wide competition. Contracting authorities decide upon the final offers on the basis of the Most Economically Advantageous Tender (MEAT) and this can limit the uptake and selection of more sustainable options.

GPP criteria are defined by product group. The last update for GPP criteria for the "food, catering services and vending machines" sector has been carried out in 2019 (European Commission, 2019). Criteria are split into selection criteria (which refer to the tenderer), technical specifications (which constitute minimum compliance requirements that must be met by all tenders), award criteria (used by contracting authority to evaluate the quality of the tenders and compare costs) and contract performance clauses (used to specify how a contract must be carried out). Further details on the current GPP criteria for the food sector are available in (Boyano et al., 2019).

1.2.3 Sustainable public procurement

Sustainable Public Procurement (SPP) is a process by which public authorities seek to achieve the appropriate balance between the three pillars of sustainable development - economic, social and environmental - when procuring goods, services or works at all stages of the consumed products[14]. The UNEP (United Nations Environment Programme) has been active in the promotion of Sustainable Public Procurement at national, regional and global levels since 2005[15]. Regarding social aspects, the Commission published the "Buying Social - a guide to taking account of social considerations in public procurement"[16]. Many public authorities in the EU (e.g. the Netherlands[17], Denmark[18]) are implementing GPP as part of a broader approach to sustainability in their purchasing, which also addresses economic and social aspects.

[12] https://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2008:0400:FIN:EN:PDF

[13] In terms of coherence with other policy instruments, GPP criteria have been based on criteria used in the granting of the European Eco-label, in particular, or, in the absence of a European label, national ecolabels (Galli et al., 2018)

[14] https://ec.europa.eu/environment/gpp/versus_en.htm

[15] https://www.unep.org/explore-topics/resource-efficiency/what-we-do/sustainable-public-procurement

[16] https://ec.europa.eu/docsroom/documents/45767

[17] Sustainable Public Procurement Webtool (mvicriteria.nl)

[18] Food | The responsible purchaser (denansvarligeindkober.dk)

2 Goal and scope of this report

The present report focuses on providing scientific insights and knowledge to analyse the environmental impacts of GPP criteria and the potential implementation of SPP. For this purpose, the study aims at answering the following research questions:

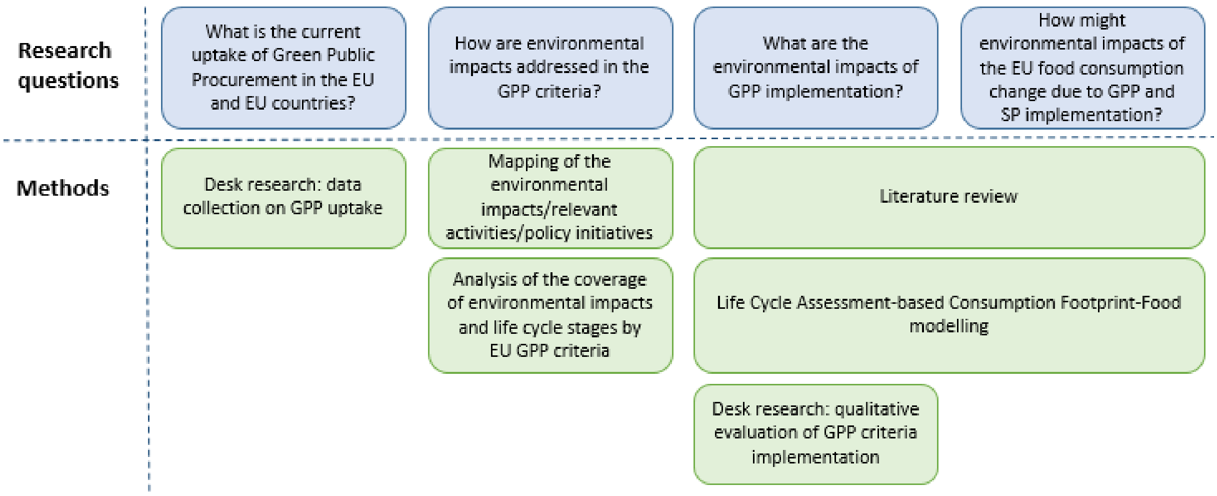
- What is the current uptake of GPP criteria in the EU and EU countries?
- How are environmental impacts addressed in the GPP criteria?
- What are the environmental effects of GPP implementation?
- How might environmental impacts of EU food consumption change due to GPP and SPP implementation?

In addition, we also aim at contributing to the wider debate on evidence support to policy, by presenting the reflections on the methodological mix which has been designed, combining various methods, to tackle in a pragmatic and sound way the complexity of the questions at stake. Figure 1 illustrates the relation among research questions and selected methodologies.

The report is organised as follows. Firstly, the methodology for the analysis is presented (Chapter 3). To ensure a system perspective, a detailed and comprehensive mapping of the environmental impacts of GPP criteria has been developed (see Section 3.1). A first, key starting point of the analysis is indeed the need to spell out in a clear and structured way the relationship existing between a certain environmental impact and the relevant activities within the food system. Then extensive desk research is presented (Section 3.2). The Consumption Footprint – Food is used to quantify the effect of dietary changes in the environmental impact of the average consumption patterns in the EU (Section 3.3). Limitations in the methodology are presented in Section 3.4.

The following chapters are dedicated to the presentation of the results: what is the current uptake of Green Public Procurement in the EU and EU countries (Chapter 4); how are environmental impacts addressed in the GPP criteria (Chapter 5); what are the environmental effects of GPP implementation (Chapter 6); how might environmental impacts of EU food consumption change due to GPP and SPP implementation (Chapter 7). Chapter 8 concludes.

Figure 1. Relation among research questions and methodologies of this study.



Source: Own elaboration

3 Methodology

3.1 Mapping of environmental impacts across the food system supply chain

The main environmental impacts considered for this study are reported in Table 1. The analysis of these impacts[19] cover a wide range of actions and aspects of the whole food system, from the manufacturing of input products until the final consumption of meals at home. For this reason, an attempt has been made to detail the relationship between the **environmental impacts** under analysis (e.g., climate change), the relevant **activities** related to this impact (e.g., energy consumption or fertilisation practices both emit greenhouse gases) and the **policy initiatives** targeting this impact (e.g., initiatives related to energy and climate, to circular economy or to organic production).

The set of these relationships is summarized in Table 2 and detailed in Annex 1, in alignment with Sanyé Mengual et al. (2024a).

Table 1. Main impacts across the environmental dimension considered for the analysis

Impact	Description
Climate change	Increase in the average global temperatures as result of greenhouse gas (GHG) emissions resulting in negative effects for the ecosystem and human health (e.g., droughts and floods, biodiversity loss).
Ozone depletion	Ozone depleting effects due to air emissions
Land use (incl. deforestation and soil health)	Impacts due to land occupation and transformation, including deforestation, and impacts associated to soil health
Water use	Water consumption and potential associated scarcity limiting available water for ecosystem
Eutrophication	Potential impact of substances contributing to terrestrial, freshwater and marine eutrophication
Ecotoxicity	Potential toxic impacts on ecosystems resulting from the emissions of toxic chemicals into the environment (e.g., pesticides), which may damage individual species as well as the functioning of the ecosystem
Particulate matter	Adverse impacts on human health caused by emissions of Particulate Matter (PM) and its precursors
Resource minerals and metals	The main aspect is the depletion of resources used along the food value chains, and dependency of resources
Biodiversity loss	Increase of pressures on biodiversity loss through environmental impacts
Waste generation	Generation of waste (non-food) along the supply chain (e.g., packaging)
Food waste generation	Generation of food loss and waste along the supply chain
Biotic resources (overexploitation)	Depletion of wild species in ecosystems due to high exploitation levels compared to reproduction

Source: Own elaboration

[19] Throughout the report, the term 'impact' is used with a neutral connotation (e.g., it needs to be specified whether it is positive or negative). However, the term 'environmental impact' is also often used in the relevant literature to refer to a negative outcome, as opposed to 'environmental benefit'. This is usually clear from the context.

Table 2. Mapping of the environmental impacts to the main hotspots along the supply chain and related policy initiatives.

Environmental impact	Relevant activities (hotspots) along the supply chain	Related policy initiatives
Climate change	Land use and land use changes (incl. deforestation), energy consumption along the supply chain (incl. fertiliser production), fertilisation, animal effluent management (incl. enteric fermentation emissions and effluents management), transportation (incl. fuels for machinery)	Energy and climate, local production, organic production, animal farming, circular economy, deforestation, supporting plant-based diets, waste management, GPP
Ozone depletion	Transportation and refrigeration, fertilisation	Local production, technological improvements, fertilisation practices, GPP
Land use (incl. deforestation and soil health)	Farmland expansion, energy production and use along the supply chain, soil management practices (such as practices that increase soil fertility and quality and prevent soil degradation – e.g., increasing soil organic matter, implementing cover crops, crops rotation, no or minimum tillage)	Energy and climate, halting deforestation, organic production, fertilisation practices, supporting plant-based diets, GPP
Water use	Irrigation, processing	Supporting plant-based diets (depending on the product[20]), circular economy, water management/conservation practices, GPP
Eutrophication	Fertilisation (incl. synthetic and organic fertilisers), animal farming, aquaculture	Fertilisation practices, organic production, animal effluent management and treatment, supporting plant-based diets
Ecotoxicity	Agrochemicals (pesticides and fertilisers)	Organic production, fertilisation practices, pesticides reduction practices, GPP, supporting plant-based diets
Particulate matter	Energy consumption along the supply chain (incl. machinery used in the fields), fertilisation, crop residues burning	Energy and climate, fertilisation practices, GPP, local production
Resource minerals and metals	Agrochemicals, packaging	Synthetic fertilisers, organic production, GPP, reusable, recyclable and compostable packaging, bio-materials
Biodiversity loss	Land use changes, farming management (concerning biodiversity at farm level: species and genetic diversity of cultivated crops and animal breed, GMO; concerning biodiversity at higher levels: ecosystem preservation or improvement, wildlife protection, protection of flora and fauna), pesticides, fisheries management	Deforestation, sustainable fishing, organic products, pesticides reduction, GMO, seeds, GPP
Waste generation	Packaging	Reusable, recyclable and compostable packaging, circular economy, waste management, GPP
Food waste generation	Food consumption (incl. households, retail and food services), processing	GPP, consumer awareness campaigns

[20] The impact of plant-based diets on water use strictly depends on the type of products (including irrigation method and geographical area considered) that substitute animal-based products. Almonds consumed in the EU, as example, are imported from regions where this crop is heavily irrigated (California, which produce over 60% of almonds worldwide) although almond production might not need irrigation in other world regions (Europe) (Vanham et al., 2020).

Biotic resources (overexploitation)	Fisheries and aquaculture, livestock feedstock	Sustainable fishing practices, animal farming, GPP

Source: Own elaboration

3.2 Desk research

In order to evaluate the current status and to substantiate the environmental impact of GPP criteria, desk research was carried out on the following main aspects:

1. Data collection on current GPP criteria uptake
2. Analysis of the coverage of environmental impacts and life cycle stages by EU GPP criteria
3. Literature review on the effects of GPP implementation on environmental impacts (including scientific papers and grey literature).
4. Qualitative evaluation of GPP implementation (e.g. GPP Good Practices)

These are detailed in section 3.2.1 (point 1 above) and section 3.2.2 (points 2 to 4 above).

3.2.1 GPP criteria uptake

GPP is a voluntary measure; currently, there is no continuous monitoring system at EU level. The last monitoring study on GPP in the EU was carried out in 2012 (Renda et al., 2012). In order to estimate the current GPP criteria uptake among Member States, official websites at EU and country level have been explored.

Data have been collected from the following sources:

- The National GPP Actions Plans (policies and guidelines)[21]
- The Joint Baltic Sea Region Report for Sustainable Public Procurement and Catering Services[22]
- GPP Advisory Group[23]
- EC-Country Reports[24]
- EC GPP website[25]
- National websites on public procurement.

Annex 2 lists the official (national, regional or at municipality level) websites used to retrieve further data on GPP uptake at country level. These websites have been retrieved either from the National sources listed in the EC GPP website, or from additional sources. Language can be a barrier for data collection with many websites using national language only.

3.2.2 Literature review

Our literature review aiming at investigating the environmental impacts of GPP was structured in three parts:

- the environmental impacts categories analysed for the Consumption footprint model (see Table 2 for the list of impacts). The keywords used were “Green” AND “Public” AND “Procurement” AND each environmental impact category (e.g. climate change). The online database Scopus was used as source;

[21] https://green-business.ec.europa.eu/green-public-procurement/advisory-group-national-action-plans_en
[22] https://www.stratkit.eu/documents/4/Joint_BSR_Report_for_Sustainable_PPCS.pdf
[23] https://green-business.ec.europa.eu/green-public-procurement/advisory-group-national-action-plans_en
[24] https://single-market-economy.ec.europa.eu/single-market/public-procurement/country-reports-and-information-eu-countries_en
[25] https://green-business.ec.europa.eu/green-public-procurement/gpp-criteria-and-requirements_en

— the impacts on more generic environmental aspects. The literature was retrieved, as for the first step, from the Scopus database using the search string "Green AND Public AND Procurement AND food" and the following keywords: sustainability, ecosystem, biodiversity, environment;

— examples of GPP practices. This exercise was conducted using grey publications and online platforms, such as GPP Good Practices26, the World Economic Forum27, and Procura+28.

3.3 Modelling the environmental impacts of GPP and SPP criteria

Modelling of the environmental impacts of GPP and SPP criteria was carried out using the Consumption Footprint model[29], which is described in Section 3.3.1. The modelling assumptions to assess GPP and SPP criteria are described in Sections 3.3.2 and 3.3.3, respectively.

The most recent update of the better regulation guidelines and toolbox (European Commission, 2021a) explicitly mentions coherently documenting models and their uses as a fundamental step for transparent and evidence informed policymaking. The Consumption Footprint is included in the Modelling Inventory and Knowledge Management System of the European Commission (MIDAS)[30].

3.3.1 The Consumption Footprint

The Consumption Footprint is a set of 16 Life Cycle Assessment (LCA)-based indicators (also available as a single weighted score) whose purpose is to quantify the environmental impacts of consumption at EU and Member State level (Sanyé Mengual & Sala, 2023a). Regarding food consumption, the Consumption Footprint includes 17 product groups with 45 representative products (Sala et al., 2023). A complete list of food products considered as representative of the different food product groups is provided in Annex 3.

The Consumption Footprint is calculated based on the consumption intensity and the environmental impact of the life cycle of each food product (i). Consumption intensity is calculated as apparent consumption:

$$Consumption\ Footprint = \sum_{i=1}^{n} Consumption\ intensity_i * Environmental\ impact_i$$
$$= \sum_{i=1}^{n} (production + imports - exports)_i * Environmental\ impact_i$$

3.3.1.1 Consumption intensity

The consumption intensity for the Consumption Footprint model is calculated for each representative product as apparent consumption per year:

Apparent consumption = Production + Imports – Exports

Consumption intensity data used in the model (detailed in Table 3) have been extracted from the Consumption Footprint results available in the Consumption Footprint Platform for the year 2018 (EC-JRC, 2022)[31]. Consumption intensity is derived from different data sources, as detailed in Table 4.

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[26] https://ec.europa.eu/environment/gpp/case_group_en.htm
[27] https://www.weforum.org/
[28] https://procuraplus.org/home/
[29] https://eplca.jrc.ec.europa.eu/ConsumptionFootprintPlatform.html
[30] MIDAS includes the model description with general information about the model; details on model structure; information on model quality and transparency; the model contribution to Commission impact assessments, https://web.jrc.ec.europa.eu/policy-model-inventory.
[31] https://eplca.jrc.ec.europa.eu/ConsumptionFootprintPlatform.html

Table 3. Consumption intensity per capita, by representative product and product group for EU-27 (2018).

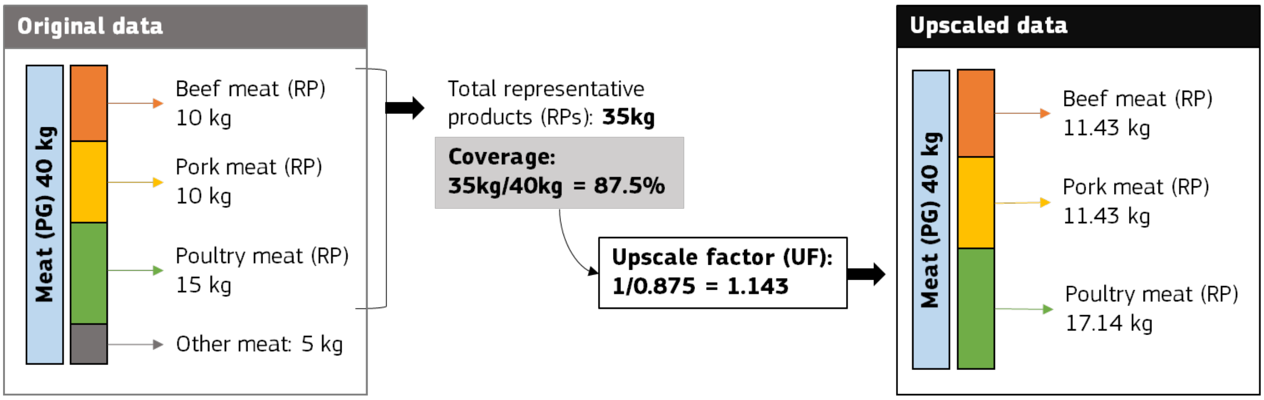
Product group	**Product**	**Consumption intensity per capita (kg)**
Beverages	Beer	70.2
Beverages	Mineral water	142.6
Beverages	Wine	29.1
Cereal-based products	Bread	37.9
Cereal-based products	Pasta	8.0
Cereal-based products	Rice	9.1
Cereal-based products	Quinoa	0.0
Coffee and tea	Coffee	5.0
Coffee and tea	Tea	0.4
Confectionary products	Biscuits	6.6
Confectionary products	Chocolate	7.1
Confectionary products	Sugar	26.8
Dairy	Butter	3.9
Dairy	Cheese	20.3
Dairy	Milk	71.4
Eggs	Eggs	13.6
Fish and seafood	Cod	12.0
Fish and seafood	Salmon	4.0
Fish and seafood	Shrimp	3.2
Fish and seafood	Tuna (canned)	4.6
Fruits	Apples	43.8
Fruits	Bananas	18.4
Fruits	Oranges	23.2
Fruits	Avocado	1.8
Fruits	Strawberry	3.6
Legume-based products	Soy beverage	0.4
Legume-based products	Tofu	0.1
Legumes	Beans	2.0
Legumes	Chickpeas	0.6
Legumes	Lentils	0.6
Meat	Beef meat (cattle)	6.1
Meat	Beef meat (dairy)	9.6
Meat	Pig meat	57.8
Meat	Poultry meat	29.8
Nuts and seeds	Almonds	3.8
Nuts and seeds	Cashew	0.9

Oils	Olive oil	4.8
Oils	Sunflower oil	8.3
Oils	Palm oil	3.4
Oils	Rapeseed oil	1.7
Oils	Soybean oil	1.5
Pre-prepared meals	Pre-prepared meals (meat-based)	3.2
Tubers	Potatoes	92.1
Vegetables	Tomatoes	72.0
Vegetables	Broccoli	17.9
Vegetables	Carrot	19.5

Source: Consumption Footprint Platform.

The consumption intensity for each representative product (Table 3) is up-scaled to cover the consumption intensity of the full product group. This means that while the list of representative products might not be exhaustive on what the product groups might encompass, the consumption amount of the overall group is considered in the analysis. For example, all consumption of meat is considered in the respective product group (PG) through the 3 representative products. Therefore, the 3 meat types modelled as representative products act as proxy for the environmental impact per unit for the remaining types of meat not individually modelled here, as illustrated in Figure 2.

Figure 2. Theoretical example of upscale step in consumption intensity calculations for the Consumption Footprint.



Source: Sanyé Mengual et al., (2023)

Table 4. Data sources[32] employed in the Consumption Footprint model to define the consumption intensity of products.

Product groups	**Data source**
Meat, Dairy, Oils, Cereal-based products, Beverages, Confectionary, Sugar, Coffee and tea, Fish and seafood, Pre-prepared meals	PRODCOM database (Eurostat, 2022a) COMEXT database (Eurostat, 2022b)
Tubers (potatoes), Eggs, Vegetables (tomato, broccoli, carrots), legumes (chickpeas, lentils, beans), fruit (oranges, apples, strawberries), tropical fruits (bananas, avocado), nuts (almonds), quinoa	FAOSTAT (2022)
Legume products (Tofu, soy milk)	EFSA (2022)

Source: Sanyé Mengual et al., (2023)

3.3.1.2 Environmental impact

To calculate the environmental impact of the life cycle of each food representative product, the Consumption Footprint employs the Environmental Footprint method as recommended by the European Commission[33]. This method includes 16 impact categories (Annex 4). An added-value of the LCA modelling is the possibility to identify potential trade-offs among environmental issues. However, it should be noted that some relevant environmental aspects could still not be covered. For example, overfishing and the impact of fishing on the seabed are not addressed in the set of impact categories. Regarding organic farming, LCA shows gaps in accounting for specific benefits of organic farming practices including carbon storage. Furthermore, the assessment of the impacts of agricultural products per kg rather than per area unbalances the comparison between organic and conventional, with organic production associated generally to a lower crop yield and efficiency than conventional production.

3.3.2 Modelling GPP criteria

The modelling of GPP implementation focuses on one of the current GPP criteria, and namely the promotion of organic food products. To model GPP uptake, in the Consumption Footprint organic products were modelled to be used in substitution to conventional products. Due to limited LCA data on organic production, this modelling was limited to products that are selected for this criterion in the EU GPP guidelines[34] (i.e., apples, oranges, potato, bread, pasta, milk, cheese, butter, beans, tomato, eggs, rice, broccoli, carrots, chickpeas, and pork, poultry and beef meat). The modelling was performed following the principles of the Consumption Footprint and leveraging on available datasets in LCA databases as well as available literature data (Sanyé Mengual et al., 2023).

3.3.2.1 Modelling assumptions for organic food products

The modelling of organic food products targeted exclusively the cultivation stage, as no relevant differences were considered for the rest of the life cycle. Data for organic cultivation was available for most of the products under assessment. In these cases, the modelling of the entire life cycle was then performed by substituting in the conventional life cycle (already available from the Consumption Footprint products) the process regarding conventional cultivation with the organic alternative (Table

[32] EC-JRC (2022). Consumption Footprint Platform. Available at: https://eplca.jrc.ec.europa.eu/ConsumptionFootprintPlatform.html (Accessed August 2022)

[33] https://environment.ec.europa.eu/publications/recommendation-use-environmental-footprint-methods_en

[34] European Commission (2019) EU green public procurement criteria for food, catering services and vending machines. SWD(2019) 366 final.

5). In the case of organic tomato cultivation, the Agribalyse database, which showed negative land use impacts because of missing land input flows, was corrected by adding land occupation flows in the tomato process, and changing greenhouse structure to use the following processes from the ecoinvent 3.6 database “Greenhouse, plastic walls and roof {FR}| greenhouse construction, plastic walls and roof, plastic tubes | APOS, S” and “Plastic tunnel {FR}| plastic tunnel construction | APOS, S”.

In the case of rice, there was no organic cultivation process available in the database, thus the Agrifootprint process for conventional rice cultivated in Italy was modified to represent organic rice cultivation. The following modifications were applied:

- Modification of seed production process to represent organic seeds without pesticides and synthetic fertilisers;
- Seed rate was increased to 220 kg/ha, because of the competition with weeds (Bacenetti et al., 2016).
- Removal of all synthetic fertilisers and addition of organic fertilisers with the same amount of nitrogen using the Agribalyse 3 process “Compost, for organic fertiliser, shredded” with the amount of 15.7 t/ha (assumption that N content of compost is 0.7%). Note that phosphorus amount can be higher in compost than what is added as synthetic fertilisers, but phosphorus emissions were not modified;
- Removal of pesticides;
- Additional fuel use due to additional work in field (Bacenetti et al., 2016).

In the case of orange, the ecoinvent 3.6 process for the conventional orange cultivation in Spain was modified to represent organic orange cultivation. The following modifications were applied:

- Modification of seedling production processes to represents organic seedlings without pesticides and synthetic fertilizers; these were replaced by adding the same amount of nitrogen using the Agribalyse 3 process ‘Compost for organic fertiliser, shredded’ with the amount of 0.56 kg/seedling assuming that N content of compost is 0.7% and N content of ammonium nitrate is 34% (Finch et al., 2002);
- Planting density is assumed the same for organic and conventional cultivation (Pergola et al., 2013);
- Removal of pesticides;
- Removal of fertilizers and addition of organic fertilizers with the same amount of nitrogen using the Agribalyse 3 process “Compost, for organic fertiliser, shredded” with the amount of 14.7 t/ha (assuming compost with 0.7% of N and ammonium nitrate with 34% of N). Note that phosphorus amount can be higher in compost than what is added as synthetic fertilisers, but phosphorus emissions were not modified.

The yield rate was not changed in the modified rice and orange processes, because it was assumed that with the same amount of nutrients the yield has the same level, although the lack of pesticides can also affect the yield. This assumption was taken due to the lack of consistent evidence on the difference between conventional and organic cultivation regarding the use of pesticides, which might depend on a case-by-case basis and the specific conditions.

In case of beef cattle meat, the Agrifootprint model was modified to represent organic cattle by changing conventional feed to organic feed. Grass and grass silage were directly changed as organic grass and organic grass silage with the same amount as in the original model. Instead compound feed was not available as an organic version and it was modified separately changing the components in the compound feed to be organic. In case of compound feed, also ingredient amounts were slightly modified, because molasses were not available as organic. Thus molasses, which amount was 5% in the original compound feed, were removed and amount was compensated by increasing amounts of other ingredients (Table 6).

Table 5. Primary production processes used in the modelling of organic products.

Product group	Representative product	Dataset used	Database/data source
Fruits	Apple	Apple, organic, national average, at orchard/FR U	Agribalyse 3
	Orange	Modifications for original Ecoinvent process “Orange, fresh grade {ES}| orange production, fresh grade | APOS, U”	Ecoinvent 3.6; Pergola et al., 2013
Vegetables	Carrot	Carrot, organic, Lower Normandy, at farm gate/FR U	Agribalyse 3
	Broccoli	Cauliflower, winter, organic, at farm gate/FR U	Agribalyse 3
	Tomato	Tomato, organic, greenhouse production, national average, at greenhouse/FR U*	Agribalyse 3
Tubers	Potato	Potato, organic {CH}| production | APOS, U	Ecoinvent 3.6
Legumes	Chickpea	Chickpea, organic, system n°1, at farm gate/FR U	Agribalyse 3
	Beans	Fava bean, organic {CH}| production | APOS, U	Ecoinvent 3.6
Cereal products	Pasta	Wheat grain, organic {CH}| wheat production, organic | APOS, U	Ecoinvent 3.6
		Egg, organic, at farm gate/FR U	Agribalyse 3
	Rice	Modifications for original Agrifootprint 5 process “Rice, at farm/IT Economic”	Agrifootprint 5; Bacenetti et al., 2016
	Bread	Wheat grain, organic {CH}| wheat production, organic | APOS, U	Ecoinvent 3.6
Eggs	Egg	Egg, organic, at farm gate/FR U	Agribalyse 3
Dairy products	Milk	‘Cow milk, organic, system n°1, at farm gate/FR U’	Agribalyse 3
	Cheese		
	Butter		
Meat	Beef meat, cattle	Modification of original Agrifootprint 5 process “Beef cattle, at farm/IE Economic”	Agrifootprint 5 + modifications
	Beef meat, dairy	Cull cow, organic, lowland milk system, silage maize 5 to 10%, at farm gate/FR U	Agribalyse 3
	Pork meat	Pig, organic, at farm gate|FR U	Agribalyse 3
	Poultry meat	Broiler, organic, at farm gate/FR U	Agribalyse 3

Source: Own elaboration. Note: * Missing “occupation, arable land” flow was added in the original dataset, and greenhouse gas structure was changed to be ecoinvent process “Greenhouse, plastic walls and roof {FR}| greenhouse construction, plastic walls and roof, plastic tubes | APOS, S” and “Plastic tunnel {FR}| plastic tunnel construction | APOS, S”.

Table 6. Datasets and amounts used in organic compound feed modelling compared to original model.

Original process	**Original amount, kg**	**Organic dataset**	**Organic amount, kg**
Barley grain, market mix, at regional storage/IE Economic	290	Barley grain, organic {GLO}| market for | APOS, U	305
Wheat grain, market mix, at regional storage/IE Economic	90	Wheat grain, organic {GLO}| market for | APOS, U	95
Rapeseed meal (solvent), market mix, at regional storage/IE Economic	150	Rapeseed meal, organic, animal feed, at plant/FR U	158
Oat grain, market mix, at regional storage/IE Economic	90	Spring oat grain, organic, at farm gate/FR U	95
Soybeans, market mix, at regional storage/IE Economic	120	Soybean, organic {GLO}| market for | APOS, U	126
Maize, market mix, at regional storage/IE Economic	210	Maize grain, organic {GLO}| market for | APOS, U	221
Molasses, market mix, at regional storage/IE Economic	50	-	-
Total	1000		1000

Source: Own elaboration

3.3.2.2 Other aspects related to public consumption not considered in this assessment

In the Consumption Footprint, in addition to using simplified assumptions to assess the uptake of GPP criteria (which is modelled as organic food uptake), it should be noted that the modelling of public supply chains also shows some differences to private consumption. Three main differences can be explored, together with the justification of the related modelling assumptions and limitations.

Firstly, in the Consumption Footprint, the food supply chain includes transport from processing to the retail by lorry, impacts from retail, and then transportation to home by using passenger car. In contrary, in the public supply chain, the whole transport is performed by lorries without impacts from retail. However, the environmental impacts from transportation and retail have lower relevance compared to overall impacts of the whole life cycle, thus these aspects were not changed in the models (Castellani et al., 2017).

Secondly, the packaging of products in the Consumption Footprint are modelled as for the private consumer, which are usually less material efficient than the packaging employed for public consumers (e.g., avoiding primary packaging, bigger packages). As a result, the packaging material per kg of product is higher in the products modelled in Consumption Footprint. According to Jungbluth et al. (2016), packaging represents about 4% of the climate impact of an average meal in canteen. Calderón et al. (2018) compared cooking of the same meal in industrial level, or in catering, restaurant or home. They noticed that packaging materials account for about 7% of total impacts in both canteen and home. Also, for the products included in the BoP Food, the packaging impact is typically less than 10%, but it can be higher for some products depending on the packaging materials. For example, climate impact of canned tuna packaging is almost 40% of the total life cycle impacts of tuna, when decreasing the packaging material would lead to significant decrease in the impacts. Although some differences might be relevant for some products, this aspect was not modelled differently as there was not any data available on the packaging amounts in public sector. However, this aspect has to be kept in mind in the interpretation of the results, particularly if diets are changed from products packed in low-impact materials (e.g. plastic) to products packed in high-impact materials (e.g. aluminium, glass).

Thirdly, energy and water consumption in the use phase, i.e. cooking of food, might be different between public and private consumers. On one hand, the public sector is expected to require less energy for cooking purposes since bigger portions are cooked at the same time. Also, the cooking and storage are usually more energy efficient in public sector compared to households due to the type of appliances employed. On the other hand, there might be additional energy consumption to keep food warm after cooking in the catering sector (Sturtewagen et al., 2016). According to the study by Calderón et al., (2018), energy consumption is responsible for 30% of total life cycle impacts in households, while in a catering this share is only 14%. Since the purpose of this study is to compare changes in diets, we consider that differences in the use phase might be similar regardless of the food under preparation and these differences remained out of the scope of this analysis.

3.3.3 Modelling SPP criteria

The potential effect of SPP uptake on environmental impact is modelled as a shift from current consumption patterns towards healthier and plant-based diets (target diets). Given the lively debate in the literature about healthy and sustainable diets, we have defined two different target diets based on (a) Food-Based Dietary Guidelines (FBDGs) in Europe[35], and b) EAT-Lancet Commission on Healthy Diets From Sustainable Food (Willett et al., 2019).

- FBDGs are science-based recommendations for healthy eating developed by different countries taking into account cultural characteristics of the country. Thus, FBDGs differ slightly between countries. For this study, the EU average FBDG was created by calculating the average recommended amount per person from the recommended amount in each EU member state. However, not all countries provided quantitative amount, thus only countries with quantitative data were included in the assessment. For example, in case of sugar only three countries provided the amount of sugar consumption per day, while others referred to e.g. moderate use.
- the EAT-Lancet Commission on Healthy Diets From Sustainable Food Systems in turn provides recommendations for a healthy diet taking into account sustainability if food production. The amounts of beverages, coffee and tea, and confectionary products were not changed.

The changes of different products with both considered dietary recommendations are presented in Table 7. The most relevant differences between the two selected recommendations are the following:

- Milk amount in FBDGs is very high compared to current consumption, while in EAT-Lancet the amount is slightly lower compared to current consumption;
- EAT-Lancet recommends lower meat consumption than FBDGs (except for poultry meat) and also lower legume consumption;
- EAT-Lancet recommends high decrease for current potato consumption, while in FBDGs potato is in the group of starchy food, which includes also cereal products.

In addition, it should be noted that for fruit consumption the baseline includes also fruits used in juices and jams, while EAT-Lancet includes only fruits consumed as such. For this reason, the fruit consumption in EAT-Lancet is lower than the current consumption in the model.

[35] https://knowledge4policy.ec.europa.eu/health-promotion-knowledge-gateway/topic/food-based-dietary-guidelines-europe_en

Table 7. Consumption coefficients used for diet change for both diets, by product and product group. Current consumption is set as 100%.

Product group	**Product**	**Diet change FBDGs**	**Diet change EAT-Lancet**
Beverages	Beer	100%	100%
Beverages	Mineral water	100%	100%
Beverages	Wine	100%	100%
Cereal-based products	Bread	115%	185%
Cereal-based products	Pasta	115%	185%
Cereal-based products	Rice	115%	185%
Cereal-based products	Quinoa	115%	185%
Coffee and tea	Coffee	100%	100%
Coffee and tea	Tea	100%	100%
Confectionary products	Biscuits	100%	100%
Confectionary products	Chocolate	100%	100%
Confectionary products	Sugar	74%	30%
Dairy	Butter	78%	65%
Dairy	Cheese	97%	65%
Dairy	Milk	242%	65%
Eggs	Eggs	84%	45%
Fish and seafood	Cod	64%	105%
Fish and seafood	Salmon	64%	105%
Fish and seafood	Shrimp	64%	105%
Fish and seafood	Tuna (canned)	64%	105%
Fruits	Apples	128%	145%
Fruits	Bananas	128%	145%
Fruits	Oranges	120%	145%
Fruits	Avocado	128%	145%
Fruits	Strawberry	100%	145%
Legume-based products	Soy beverage	100%	180%
Legume-based products	Tofu	581%	180%
Legumes	Beans	581%	180%
Legumes	Chickpeas	581%	180%
Legumes	Lentils	581%	180%
Meat	Beef meat (cattle)	30%	22%
Meat	Beef meat (dairy)	30%	22%
Meat	Pig meat	30%	22%
Meat	Poultry meat	43%	80%

Nuts and seeds	Almonds	198%	190%
Nuts and seeds	Cashew	198%	190%
Oils	Olive oil	78%	76%
Oils	Sunflower oil	78%	76%
Oils	Palm oil	78%	76%
Oils	Rapeseed oil	78%	76%
Oils	Soybean oil	78%	76%
Pre-prepared meals	Pre-prepared meals	43%	40%
Tubers	Potatoes	115%	24%
Vegetables	Tomatoes	167%	125%
Vegetables	Broccoli	167%	125%
Vegetables	Carrot	167%	125%

Source: Own elaboration

3.4 Methodological limitations

When interpreting the results, the following limitations would need to be taken into account.

First of all, the performed desk research faced a major limitation due to the lack of data on GPP uptake (including of individual GPP criteria), both at European and country level. Studies on the evaluation of GPP implementation and its effects are also very rare. A monitoring system/scheme as part of new legislation on public procurement would improve the current availability of data.

Regarding the modelling, the biggest limitations are related to the comparability of organic and conventional products. Since the products compared are modelled based on different data sources and countries, the results have an additional layer of uncertainty associated to available datasets. Most of the organic products were available only in French Agribalyse database, and thus represent the French agriculture and conditions, while conventional models are taken from ecoinvent or Agrifootprint databases using mainly Dutch or German data (Table 8). However, sometimes another country was selected to be the most representative, e.g. tomato is based on Spanish cultivation, and apple and rice on the Italian one. For example, conventional cultivation of broccoli in the Netherlands needs irrigation according to the Agrifootprint database, while organic broccoli cultivation in France is not irrigated according to the data in the Agribalyse database. In addition, according to Agribalyse, there are phosphorus fertilizer inputs in organic broccoli and carrot cultivation, while there is no phosphorus fertilization in their conventional cultivation in the Netherlands. In order to achieve more comparable results, data of both cultivation systems, organic and conventional, should preferably come from the same country. It should also be noted that some positive impacts of organic agriculture are not captured by LCA, such as the positive impacts of organic agriculture to biodiversity and soil quality.

Table 8. Databases and countries of origin of the considered products.

Product	Database / country of origin	
	Conventional	**Organic**
Apple	Ecoinvent 3.6 / Italy	Agribalyse 3 / France
Orange	Ecoinvent 3.6 / Spain	Ecoinvent 3.6 / Spain with modifications
Carrot	Agrifootprint 5 / the Netherlands	Agribalyse 3 / France
Broccoli	Agrifootprint 5 / the Netherlands	Agribalyse 3 / France
Tomato	Ecoinvent 3.6 / Spain	Agribalyse 3 / France
Potato	Agrifootprint 5 / Germany	Ecoinvent 3.6 / Switzerland
Chickpea	Agrifootprint 5 / Turkey	Agribalyse 3 / France
Beans	Agrifootprint 5 / the Netherlands	Ecoinvent 3.6 / Switzerland
Rice	Agrifootprint 5 / Italy	Agrifootprint 5 / Italy with modifications
Wheat (bread and pasta)	Agrifootprint 5 / Germany	Ecoinvent 3.6 / Switzerland
Egg	Agrifootprint 5 / the Netherlands	Agribalyse 3 / France
Milk (also cheese and butter)	Agrifootprint 5 / the Netherlands	Agribalyse 3 / France
Beef meat, cattle	Agrifootprint 5 / Ireland	Agrifootprint 5 / Ireland with modifications
Beef meat, dairy	Agrifootprint 5 / the Netherlands	Agribalyse 3 / France
Pork meat	Agrifootprint 5 / the Netherlands	Agribalyse 3 / France
Poultry meat	Agrifootprint 5 / the Netherlands	Afribalyse 3 / France

Source: Own elaboration

4 What is the current uptake of Green Public Procurement in the EU and EU countries?

The European Commission set an indicative target that, by 2010, 50% of all public tendering procedures should be compliant with endorsed common core EU GPP criteria (European Commission, 2008). Our desk research unveiled a limited availability of data regarding GPP implementation as well as the level of implementation of the different GPP criteria. The current GPP provisions are of a voluntary nature, and no monitoring scheme in place. Furthermore, when GPP is applied, contracting authorities have the possibility to decide the thresholds and which criteria to consider for their tenders. As a result, the extent and the efficiency of GPP are hard to evaluate.

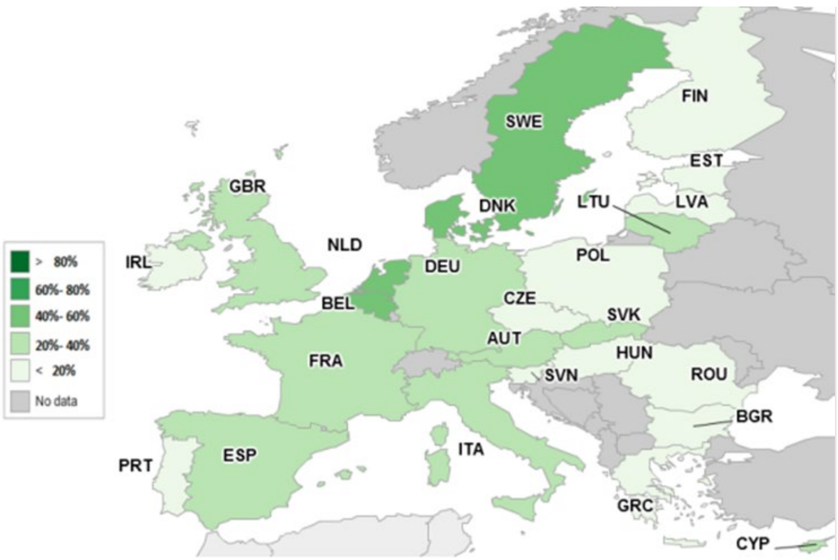
The last **monitoring study on GPP** in the EU was carried out in 2012 (Renda et al., 2012). Although the uptake is significant, Renda et al., (2012) reported that the 50% target had not been met. Furthermore, the report pointed out at the factors that made it difficult to monitor the GPP uptake, such as:

- the variety of definitions adopted by each Member State of what belongs to each product group;
- the very limited availability of data on GPP in official European/national statistics.

EU GPP criteria implementation varies across Member States, ranging from 40-60% to less than 20%. The report highlighted that **the lowest price of products was still the most widely employed decisive criterion in the majority of countries**, while only a minority used Life Cycle Costing as evaluation methods.

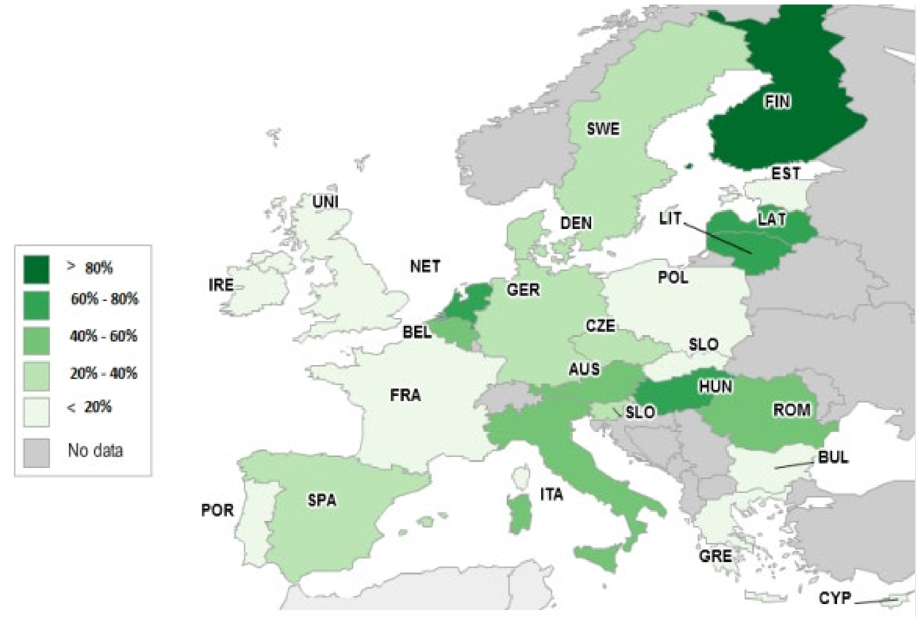
Figure 3 and Figure 4 show how fragmented the situation was in 2012 among EU countries, as well as differences when comparing number of contracts and their economic value. When observing the number of contracts, The Netherlands, Sweden, Denmark and Belgium were the only countries with more than 40% of GPP uptake. When considering the economic value of the contracts, other countries emerged with GPP uptake beyond 60%, such as Finland or Latvia. The uptake of EU core GPP criteria does not vary only across Member States, but also across product groups. Some products groups (furniture, textiles, food products and catering services, as well as construction) had a level of uptake of all core criteria below 20% (Figure 5). Furthermore, as shown in Figure 6, for the group “Food and catering services”, the two core criteria for organic food and environment-friendly packaging had respectively an uptake of 34% and 28% (Renda et al., 2012).

Figure 3. Uptake of GPP in the EU27 (last contracts by number). 2012.



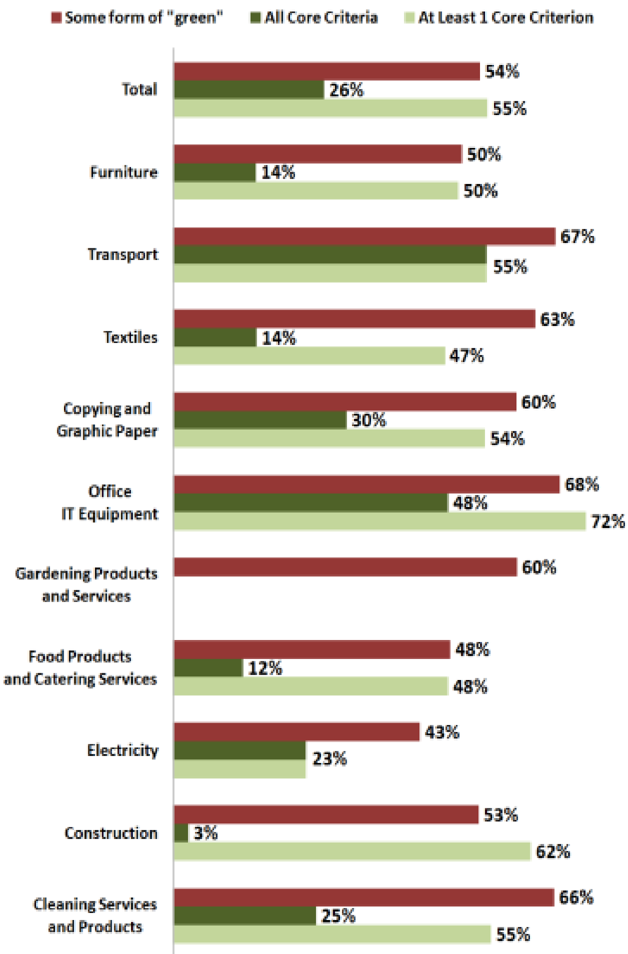
Source: Renda et al., (2012)

Figure 4. Uptake of GPP in the EU27 (last contracts by value). 2012.



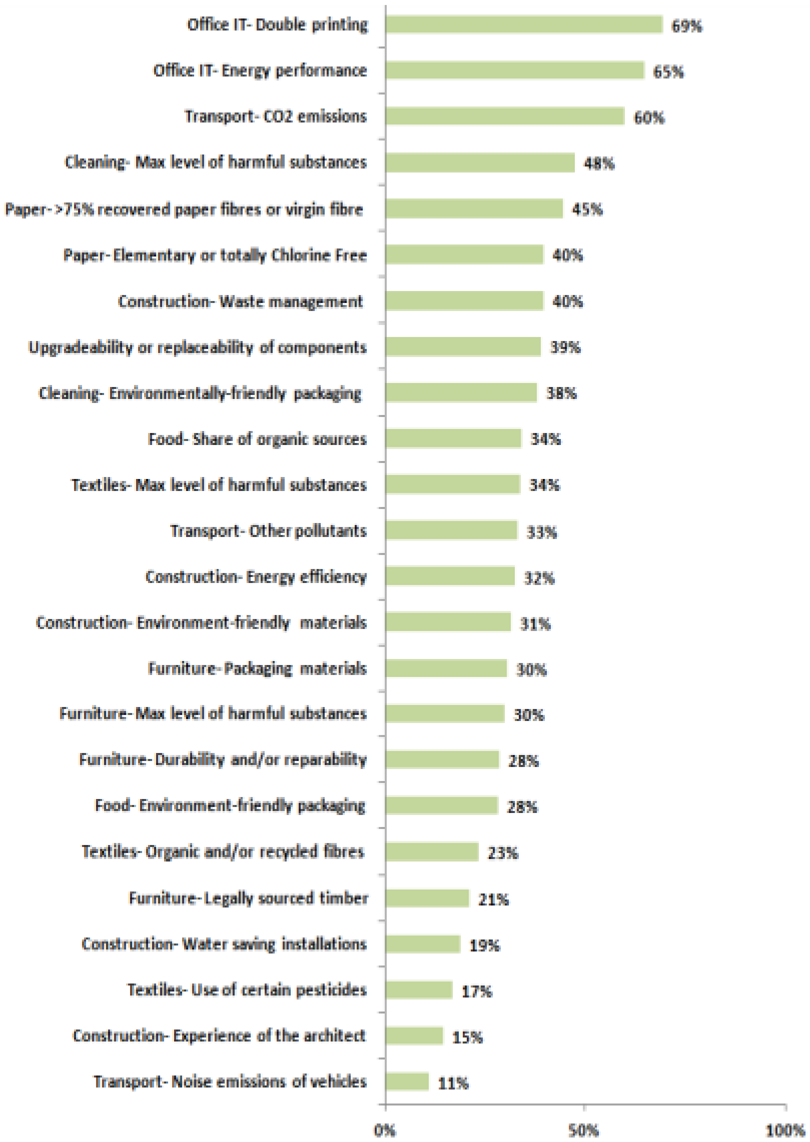
Source: Renda et al., (2012)

Figure 5. Green contracts by number of contracts. 2012.



Source: Renda et al., (2012)

Figure 6. Uptake of individual EU core criteria for nine products groups.



Source: Renda et al., (2012)

4.1 Country-level uptake of GPP for the food sector

The National GPP Actions Plans (policies and guidelines)[36] contain a comprehensive overview of the situation in the 27 EU Member States. According to the summary report for 2022 (NAPs, 2022), **in 2022 only 11 countries confirmed to have developed national GPP criteria for food** (Austria, Belgium, Denmark, Finland, France, Italy, Latvia, Lithuania, Slovenia, Spain and Sweden). Of all these countries, only France provides detailed information on the legislation adopted: the "Egalim" law (2018)[37] on sustainable food requires that from 1 January 2022 meals served in collective catering must include 50% of quality sustainable food products, including at least 20% from organic farming.

[36] https://green-business.ec.europa.eu/green-public-procurement/advisory-group-national-action-plans_en
[37] https://www.legifrance.gouv.fr/jorf/id/JORFTEXT000037547946

According to the Joint Baltic Sea Region Report for Sustainable Public Procurement and Catering Services (StratKit)[38], also Finland adopted GPP criteria that are binding at central governance level.

Another source of information is the GPP Advisory Group[39]. The GPP Advisory Group is composed by experts of the EU Member States and the following stakeholders: Business Europe, UEAPME (small and medium enterprises association), European Environment Bureau/BEUC (European Consumer Organisation), ICLEI – Local Governments for Sustainability. They have the role to support and give advice to the European Commission on the implementation of GPP practices. The last update on GPP activities (March 2022)[40] shows that the situation varies across countries: while some countries are still working on the elaboration of national GPP criteria for Food and Catering Services (e.g. Slovakia, Estonia) others have already updated them (e.g. Sweden). More details are available regarding:

1. Denmark: criteria for procurement goals on "Food" are expected to be finalized by 2022-2023.
2. Hungary: there are new legislation imposing mandatory rules in terms of sustainable public catering. Pursuant to Government Decree No. 676/2020, contracting authorities will be obliged to insert as contract performance clause the following: i) As of 1 January 2022, minimum 60 percent of the total value of products procured; ii) As of 1 January 2023, minimum 80 percent of the total value of products procured shall consist of products procured in short public catering supply chains, respectively shall originate from local food products.

Further data on GPP uptake and threshold set by countries were found for Malta, Lithuania (for these two countries the source was EC-Country Reports, 2021[41]), Latvia, Italy, Germany, and Denmark. Many of the reports were only available in the mother tongue of each country, making it hard to retrieve data. In general, analysed data show a **positive trend in the uptake of GPP criteria among Member States but with heterogeneous level of current implementation**.

- Denmark

In 2013, the share of green contracts for food and catering services reached 69%[42].

- Germany

As previously mentioned, the National report on GPP[43] combines in one category food, beverages, tobacco and related products. According to this report, the share of GPP contracts for such category, at national level, accounted for less than 5% of the volume of all public contracts between 2009 and 2015 (considering the number of contracts).

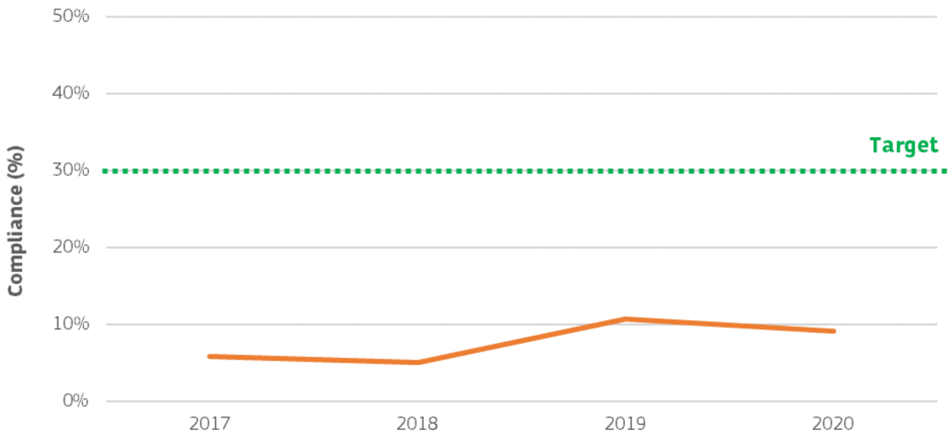
- Malta

The first NAP was adopted for the years 2012-2014 and considered the "Food and Catering services" sector among the non-mandatory GPP ones, setting a national target of 30% for 2014. The second NAP, instead, will set a mandatory status for seven additional sectors, including the new group "Hospitality and catering services", starting from 2025[44]. The national targets set with the second NAP, which can be adjusted throughout the lifespan of the NAP, are shown in Table 9. Current data on GPP criteria uptake for "Food and Catering services" show that even though there is a positive

[38] https://www.stratkit.eu/documents/4/Joint_BSR_Report_for_Sustainable_PPCS.pdf
[39] https://ec.europa.eu/environment/gpp/expert_meeting_en.htm
[40] https://circabc.europa.eu/ui/group/44278090-3fae-4515-bcc2-44fd57c1d0d1/library/9fbeef22-2ce2-46a7-a20d-87ba1f5151e0/details
[41] https://single-market-economy.ec.europa.eu/single-market/public-procurement/country-reports-and-information-eu-countries_en
[42] https://www2.mst.dk/Udgiv/publikationer/2016/01/978-87-93435-20-9.pdf
[43] Using public procurement as a decarbonisation policy: A look at Germany (econstor.eu)
[44] https://meae.gov.mt/mt/Public_Consultations/MSDEC/Documents/Green%20Public%20Procurement%20National%20Action%20Plan.pdf

trend (see Figure 7), the national target seems still far from being reached: the national target was set at 30% for 2020 while the compliance for the year 2020 was 9.1% (EC-Country Reports, 2021).

Figure 7. Malta. GPP compliance through the years (EC-Country Reports, 2021).



Source: Own elaboration

Table 9. Malta. National targets for the "Hospitality and Catering Services" group

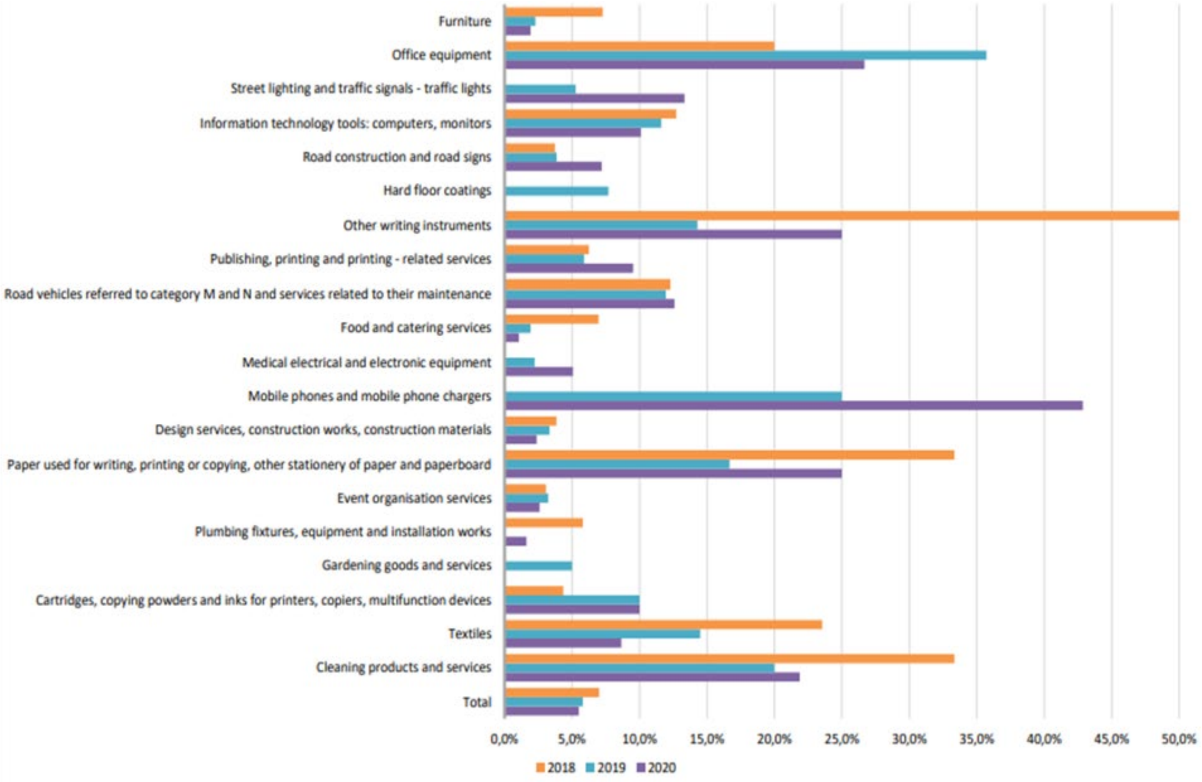
Sector	**National targets**						
	2019	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**
Hospitality and Catering Services	10%	20%	30%	50%	60%	80%	100%

Source: Own elaboration

- Lithuania

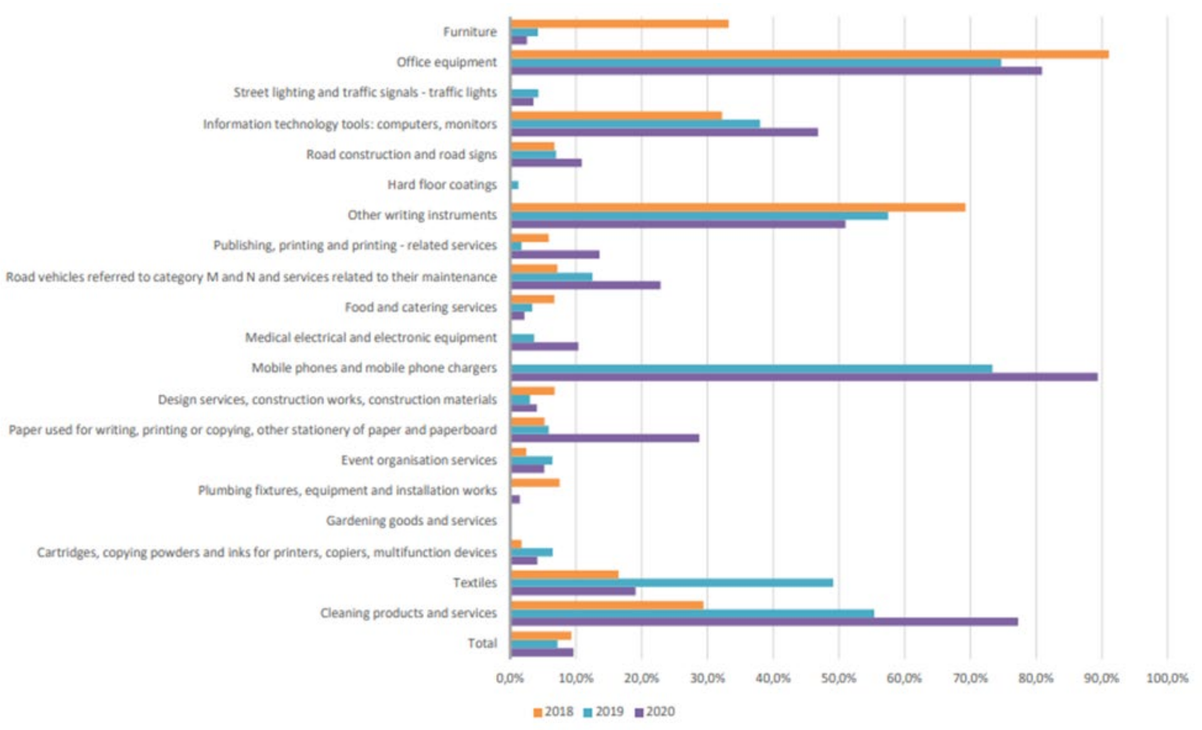
Lithuania has developed national GPP criteria for Food and catering services. From 2018 to 2020 there has been a negative trend considering both the number and the economic value of GPP products (Figure 8 and Figure 9; EC-Country Reports, 2021).

Figure 8. Lithuania. Share of GPP contracts by group, whose procurement is subject to environmental criteria



Source: EC-Country Reports, 2021.

Figure 9. Lithuania. Economic value of GPP products by product, whose procurement is subject to environmental criteria.



Source: EC-Country reports, 2021

- Latvia

In Latvia, the Cabinet of Ministers Regulations of 28 October 2014 No. 673 'Regulations on application of environmental criteria and determination of selection criteria in procurement of food supply and catering services' were adopted[45] regarding GPP. Data on the current uptake of GPP criteria are available on the website of the Ministry of Environmental Protection and Regional Development[46]. The trend of GPP expenditure from 2015 to 2020 for food products and catering services started to show growth only from 2017 (Table 10 and Table 11). In 2020 a small reduction in GPP contracts can be observed, which could be due to the Covid19 pandemic. When assessing 2020 data, the use of GPP criteria in public procurement of the food sector is of 83% (in number) or 96% (in economic value), highlighting the large uptake of GPP in this country. Nevertheless, it is relevant to point out that often many public tenders include only one mandatory GPP criterion (e.g. "no GMO") rather than considering the whole set of GPP criteria (Simanovska et al., 2020) .

Table 10. Latvia. Evolution of GPP contracts in economic value (million euro) from 2015 to 2020.

Sector	Economic value of GPP contracts (M€)					
	2015	2016	2017	2018	2019	2020
Food products and catering services	86,5	81,1	52,8	11,7	12,6	11,4

Source: Own elaboration

Table 11. Latvia. GPP data for 2020 in terms of number of purchases and economic value, with respect to total public procurement on the food sector.

	Number of purchases			Economic value of contracts (M€)		
Year 2020	Total	GPP	%	Total	GPP	%
Food products and catering services	489	405	82.8%	119,2	114,1	95.7%

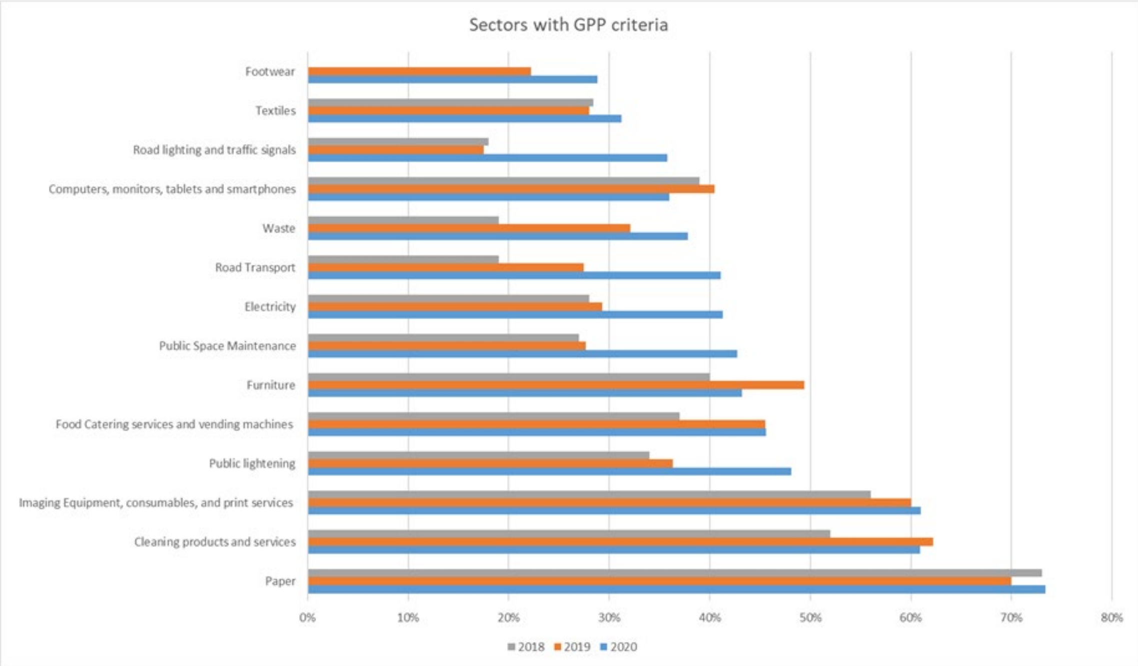
Source: Own elaboration

- Italy

In Italy, the new Procurement Code (Legislative Decree 50/2016 and Legislative Decree 56/2017[47]) makes it mandatory for public authorities to adopt "minimum environmental criteria" also for the food and catering service sector. Legambiente and the Osservatorio "Appalti verdi" carried out a study (Legambiente, 2021) on the current level of GPP in Italy. The survey involved municipalities, protected areas and Local Health Authorities. From 2018 to 2020, the uptake of GPP criteria for the catering services sector has shown an increasing trend reaching up to 45% (see Figure 10). Also in this case, data for the year 2020 might have been affected by Covid-19 pandemic.

[45] https://faolex.fao.org/docs/pdf/lat190900ENG.pdf
[46] https://www.varam.gov.lv/lv/normativais-regulejums-un-metodiskais-atbalsts
[47] https://www.gazzettaufficiale.it/eli/id/2017/05/5/17G00078/sg

Figure 10. Italy. GPP criteria adoption for 2018, 2019, 2020.



Source: Own elaboration based on Legambiente, (2021)

4.2 Uptake of individual GPP criteria

The margin of manoeuvre of contracting authorities in defining criteria and thresholds might cause a "greenwashing" effect, as demonstrated by Simanovska et al., (2020). In their work it is also highlighted how self-reporting is not an appropriate method to measure implementation level of GPP. According to the literature review on public procurement of food by Molin et al., (2021) at global level, studies mostly focus on food waste and organic food, together with buying local and seasonal food.

In our desk research on GPP criteria uptake, we collected data on GPP criteria set/suggested at national level for 9 countries (Sweden, Slovenia, Italy, Latvia, Italy, Ireland, the Netherlands, Malta, Austria and Denmark). Since thresholds are in most cases decided by public authorities (e.g. at municipality level), it is not possible to perform a full comparison among countries. Table 12 shows on which topics each country has focused on and how the GPP criteria legal regulation works (if retrieved). It is evident how organic products, certified products and packaging represent the main actions considered by national authorities.

Table 12. Main focuses of GPP criteria (technical specifications)

Country	Focus of GPP criteria	Legal status
Sweden[48]	Organic products; Non-GMO products; Food safety; Certified sustainable products; Packaging; Animal welfare; Plant-based menu	Voluntary
Slovenia[49]	Organic products; Certified sustainable products; Seasonal products	-

[48] https://www.upphandlingsmyndigheten.se/kriterier/#om_vara_kriterier
[49] https://www.gov.si/assets/ministrstva/MJU/DJN/Zeleno-JN/ZeJN_P2_zivila-2021.docx

Latvia[50]	Non-GMO products; Packaging; Seasonal products; Plant-based menu	-
Italy[51]	Organic products; Certified sustainable products; Food waste; Waste generation, Plant-based menu; Food safety	GPP criteria ("Criteri Ambientali Minimi") are mandatory at national level
Ireland[52]	Organic products; Sustainable marine and aquaculture products; Packaging; Egg production methods; Environmentally responsible vegetable fats	All procurement using public funds must include green criteria by 2023.
The Netherlands[53]	Plant-based menu; Animal welfare; Certified sustainable products; Packaging; Waste generation	-
Malta[54]	Packaging; Waste generation; Seasonal products	Criteria for "Hospitality and catering services" will be mandatory from 2025
Austria[55]	Organic products; Certified sustainable products; Animal welfare; Local products	Binding for Federal ministries and subordinated departments[56]
Denmark[57]	Seasonal products; Certified sustainable products; Organic products; Food waste; Packaging; Animal welfare; Plant-based menu; Waste generation; Energy	-

Source: Own elaboration

Other sources (Google and Google Scholar) were used to find further data on the implementation and environmental assessment of GPP at country level. Information was found for Latvia, Denmark, Sweden, Austria.

- Latvia

Simanovska et al., (2020) show that all public tenders for food products evaluated for their work applied the MEAT award criterion together with the award criteria. In this case, to comply with the national GPP rules, they needed to include at least 3 criteria. Most of the tenders included only one mandatory criterion, in this case "no GMO", rather than considering the whole set of GPP criteria.

- Denmark

Denmark is often considered a good example of GPP criteria implementation. The WHO report on sustainable public food procurement (WHO, 2022) uses as example the City of Copenhagen wholesaler tender for the purchase and delivery of food to production kitchens and Denmark as conversion experience towards organic products.

According to Sørensen et al., (2016), there has been a significant increase in the level of organic food procurement among public kitchens participating in the Danish Organic Action Plan 2020. Holmbeck, (2020) shows that the organic area of horticultural crops (mainly fruit and vegetables) accounts for 29% of the total area of horticultural crops, compared with 17% in 2015. Imports of organic fruit

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[50] Annex_1_of_the_regulation.pdf - Google Drive
[51] https://www.gazzettaufficiale.it/eli/id/2020/04/04/20A01905/sg
[52] https://www.epa.ie/publications/circular-economy/resources/GPP-Guidance-for-the-Irish-Public-Sector.pdf
[53] Search and add - Sustainable Public Procurement Webtool (mvicriteria.nl)
[54] Green Public Procurement National Action Plan.pdf (gov.mt)
[55] https://www.nabe.gv.at/wp-content/uploads/2021/06/naBe-Aktionsplan-2020.pdf
[56] https://projects2014-2020.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1655474621.pdf
[57] https://denansvarligeindkober.dk/baeredygtighedskrav?kategori=p8

and vegetables increased from DKK (Danish crowns) 0.8 billion in 2015 to DKK 2.0 billion in 2019. In addition to retail, food service (catering etc.) is a major buyer of organic food. As a result of the increase in organic sales, prices of organic products have started to decrease (but they are still higher than the conventional products prices) and more public kitchens are turning to organic produce.

- Austria

Austria contributes to achieve its sustainability goals for public administration through the Austrian Action Plan for Sustainable Public Procurement (naBe Action Plan). GPP criteria on procurement of organic products set the minimum share of organically produced food from 25% in 2023 to 55% in 2030 (Nabe[58]). Other relevant aspects considered by the naBe Action Plan are represented by: high animal welfare standards for the procurement of food of animal origin; fish from regional waters or sustainable aquacultures; at least one vegetarian or vegan main course daily; information on the origin of meat, eggs and milk must be available close to the point of serving; reusable packaging and transport systems; measures to avoid food waste.

- Sweden

According to Upphandlings myndigheten[59], as a result of public food purchasing in Sweden, approximately 539,000 tonnes of greenhouse gases are generated each year. Their statistics show that GHGs emissions, as a result of public food purchases, decreases both per kilogram and per Swedish crown. Per kilogram of food, public food purchases generated greenhouse gas emissions corresponding to an average of 1.97 kg CO_{2eq} in 2019. Since the climate impact varies greatly depending on the food examined, this measure should be used with some caution. The percentage of organic food in the public sector in 2019 was 38%, this can be compared to the 9% of total food sales in Sweden (considering that in 2017, a more ambitious new policy stated the organic share of the public sector's food consumption to be 60% and the share of organic farmland to reach 30% by 2030 Lindström et al., (2020)). Apart from the GPP criteria implementation, there are several other initiatives for sustainable and public sector meals, such as:

- The Swedish Food Agency runs a national competence centre for meals within health care and schools;
- The Rural Network runs the project MATtanken (Food thought/tank) to contribute to sustainable public sector meals;
- “Måltid Sverige” (Meal Sweden) is an anchor/hub for public sector meals and is based on regional cooperation;
- Regional initiatives for promoting sustainable public meals[60].

Further data are provided by the FAO reports (FAO, 2021b; FAO, 2021c), which collect several examples of GPP implementation from all over the world.

The case studies describing GPP implementation in European countries illustrated examples in a few cities from Italy, France, Denmark and from one of the Strenght2Food project[61].

[58] https://www.nabe.gv.at/en/food-and-catering-services/

[59] https://www.upphandlingsmyndigheten.se/branscher/upphandling-av-livsmedel-och-maltidstjanster/

[60] https://summitdialogues.org/wp-content/uploads/2021/09/Swedish-National-Pathway-for-Sustainable-Food-Systems-Final.pdf

[61] https://www.strength2food.eu/wp-content/uploads/2019/03/D6.3-Evaluation-of-environmental-economic-and-social-impacts-of-different-PSFP-models-compressed.pdf

5 How are environmental impacts addressed in the GPP criteria?

To show which impacts are directly addressed by GPP provisions, a mapping between GPP criteria and environmental impact categories has been done for food procurement (Table 13), catering services (Table 15) and vending machines (Table 17). The analysis shows that most categories of environmental impacts are addressed by at least one GPP criterion, although this coverage is not homogeneous. Environmental impacts that are most commonly addressed are biodiversity loss and climate change. When looking at the life cycle stages addressed by GPP, the most targeted ones turn out to be production and consumption both in food procurement (Table 14), and catering services (Table 16) and vending machines (Table 18). A summary table is provided in Annex 5.

Table 13. Mapping between GPP criteria for 'Food procurement' and environmental impact categories.

Product group	**Criteria category**	**GPP criteria**	Climate change	Ozone depletion	Land use (incl. deforestation and soil health)	Water use	Eutrophication	Ecotoxicity	Particulate matter	Resource minerals and metals	Biodiversity loss	Waste generation	Food waste generation	Biotic resources (overexploitation)
Food procurement	Technical specifications	Organic food products	■		■		■	■		■	■			
		Marine and aquaculture food product									■			■
		Animal welfare												
		More environmentally responsible vegetable fats			■						■			
	Award criteria	Additional organic food products	■		■		■	■		■	■			
		Additional marine and aquaculture food products									■			■
		Additional animal welfare												
		Fair and ethical trade products	■		■			■			■			
	Contract performance clauses	Procurement management practices												

Source: Own elaboration

Table 14. Mapping between GPP criteria for 'Food procurement' and life cycle stages.

Product group	**Criteria category**	**GPP criteria**	Primary production	Manufacturing	Distribution	Consumption	End of life
Food procurement	Technical specifications	Organic food products	■				
		Marine and aquaculture food product	■				
		Animal welfare	■				
		More environmentally responsible vegetable fats	■				
	Award criteria	Additional organic food products	■				
		Additional marine and aquaculture food products	■				
		Additional animal welfare	■				
		Fair and ethical trade products	■				
	Contract performance clauses	Procurement management practices					

Source: Own elaboration

Table 15. Mapping between GPP criteria for 'Catering services' and environmental impact categories.

Product group	**Criteria category**	**GPP criteria**	Climate change	Ozone depletion	Land use (incl. deforestation and soil health)	Water use	Eutrophication	Ecotoxicity	Particulate matter	Resource minerals and metals	Biodiversity loss	Waste generation	Food waste generation	Biotic resources (overexploitation)
Catering services	Technical specifications	Food procurement												
		Plant-based menus	■	■	■		■	■	■	■	■			
		Food and beverage waste prevention											■	
		Other waste: prevention, sorting and disposal										■		
		Chemical products and consumable goods										■		
		Energy and water consumption in the kitchens	■	■		■								
		Food transportation	■						■					
		Environmental management measures and practices												
	Award criteria	Chemical products and consumable goods										■		
		Energy and water consumption in the kitchens	■	■		■								
		Food transportation (Air pollutant emissions, Greenhouse gas emissions, Refrigerants)	■	■					■					
	Contract performance clauses	Provision of low impact drinking water										■		
		Purchase of new kitchen equipment and vehicles	■	■					■					
		Environmental management measures and practices												
		Staff training												

Source: Own elaboration

Table 16. Mapping between GPP criteria for 'Catering services' and life cycle stages.

Product group	Criteria category	GPP criteria	Primary production	Manufacturing	Distribution	Consumption	End of life
Catering services	Technical specifications	Food procurement	■				
		Plant-based menus				■	
		Food and beverage waste prevention				■	
		Other waste: prevention, sorting and disposal				■	■
		Chemical products and consumable goods				■	
		Energy and water consumption in the kitchens				■	
		Food transportation			■		
		Environmental management measures and practices					
	Award criteria	Chemical products and consumable goods				■	
		Energy and water consumption in the kitchens				■	
		Food transportation (Air pollutant emissions, Greenhouse gas emissions, Refrigerants)			■		
	Contract performance clauses	Provision of low impact drinking water				■	
		Purchase of new kitchen equipment and vehicles			■	■	
		Environmental management measures and practices					
		Staff training					

Source: Own elaboration

Table 17. Mapping between GPP criteria for 'Vending machines' and environmental impact categories.

Product group	Criteria category	GPP criteria	Climate change	Ozone depletion	Land use (incl. deforestation and soil health)	Water use	Eutrophication	Ecotoxicity	Particulate matter	Resource minerals and metals	Biodiversity loss	Waste generation	Food waste generation	Biotic resources (overexploitation)
Vending machines	Technical specifications	Organic food products	■		■		■	■		■	■			
		More environmentally responsible vegetable fats			■						■			
		Smart controls												
		Reusable cups										■		
	Award criteria	Additional organic food products	■		■		■	■		■	■			
		Fair and ethical trade products	■		■			■			■			
		Annual energy consumption	■											
	Contract performance clauses	Purchase of new vending machines												

Source: Own elaboration

Table 18. Mapping between GPP criteria for 'Vending machines' and life cycle stages.

Product group	Criteria category	GPP criteria	Primary production	Manufacturing	Distribution	Consumption	End of life
Vending machines	Technical specifications	Organic food products	■				
		More environmentally responsible vegetable fats	■				
		Smart controls					
		Reusable cups				■	
	Award criteria	Additional organic food products	■				
		Fair and ethical trade products	■				
		Annual energy consumption				■	
	Contract performance clauses	Purchase of new vending machines					

Source: Own elaboration

A more detailed analysis of how each criterion affects the different environmental impact categories is provided here below.

— Criterion "Organic food products"

Organic production is defined as "an overall system of farm management and food production that combines best environmental and climate action practices, a high level of biodiversity, the preservation of natural resources and the application of high animal welfare standards and high production standards in line with the demand of a growing number of consumers for products produced using natural substances and processes"[62]. It represents a concrete but still debated suggestion for improving the sustainability of the food system, due to the lower yields compared to conventional agriculture (Seufert et al., 2012) and to lower soil organic carbon stocks (Lorenz & Lal, 2016). Nevertheless, organic agriculture presents important environmental benefits: it leads **to lower CO_2 ,N_2O and CH_4 emissions**, enhanced soil and **water quality** and lower energy use per land area (Lorenz & Lal, 2016). Furthermore, organic farming methods have a strong positive effect on total **microbial abundance** and activity in agricultural soils compared to conventional agriculture (Lori et al., 2017) and perform better than conventionally managed crop systems during climate extremes (Lotter, 2003). Organic farming tends to rely on a higher number of crops, compared to conventional farming, because of the very nature of the management system, involving rotation, cover crops, intercropping and leading in this way to a better **natural pest control**, as natural habitats provide shelter for a broad spectrum of natural species that operate as pest control (Gomiero et al., 2011). The impact on water use is still unclear: while improved soil quality from organic management provides some advantages for water management, lower organic yields imply unclear impact per unit of crop output (Seufert & Ramankutty, 2017). The performance of organic farming should be improved further, particularly in terms of yields, water management and consumer accessibility. Organic farming has a direct positive effect on **ecotoxicity** as a result of restrictions in the use of pesticides, which represent the main driver of this environmental impact (UNEP, 2016a). Organic farming has large positive effects on biodiversity compared with conventional farming, although the magnitude of the effect varies with the organism group and crop studied (Tuck et al., 2014). Inputs use is strictly regulated in organic agriculture, but some fertilizers/pesticides are still allowed, causing a negative impact on **resource minerals and metals**. The use of copper (as fungicide), mineral oils (as insecticide and fungicide) and phosphorus (coming from phosphate rocks) can lead to a higher

[62] Regulation (EU) 2018/848 of the European Parliament and of the Council of 30 May 2018 on organic production and labelling of organic products and repealing Council Regulation (EC) No 834/2007

use of mineral and metals resource in organic products (Varga et al., 2022; Tamm et al., 2022). Furthermore, regarding waste generation, no study has been found highlighting the difference on packaging use between organic and conventional products.

— Criterion "Marine and aquaculture food product"

The technical specification criterion "Marine and aquaculture food product" states that no fish or fish products are to be used from species and stocks identified in a fish to avoid´ list that reflects the state of fish stocks in different regions. The list and the thresholds are to be defined by the contracting authorities. At the moment, there are several lists that can support this criterion (e.g. the Marine Conservation Society 'fish to avoid', WWF's sustainable seafood guides, IUCN, Seaweb Europe, FAO, NOAA). The species purchased must be marked as green in the yearly fishing quotas and allowable catches of the European Commission (Boyano et al., 2019). The origin of fish is also decided by public authorities (e.g. in Italy fish should come from FAO fishing areas 37 or 27[63], while the city of Vienna allows fish and fish products coming from other FAO fishing areas[64]). Regarding organic products, according to the EUMOFA report (EUMOFA, 2021), in Germany, Spain, France, Italy, and UK, of the 2020 total average consumption of unprocessed fishery and aquaculture products through retail, food services and institutional channels, around 1,5% was organic.

In order to help release pressure on over-fishing, the activity and turnover of aquaculture has progressively increased. Nevertheless, an important aspect to consider regarding aquaculture is the use of wild fish as aquafeed (Farmery et al., 2017). Novel aquaculture feeds, including algal, microorganism and insect meals, are increasingly available but currently account for a small fraction of feeds (Gephart et al., 2021). The production of more fish alternative products would probably increase in the future, although it is necessary to consider if they can provide the same nutritional value (Alcorta et al., 2021).

— Criterion "More environmentally responsible vegetable fats"

This criterion supports the purchase of products that meet the requirements of a certification scheme (regarding soil, biodiversity, land-use change and organic carbon stocks). Some examples are the Roundtable on Sustainable Palm Oil - RSPO[65], Palm Oil Innovation Group - POIG[66], the Roundtable on Responsible Soy - RTRS[67], the Soybean Sustainability Assurance Protocol - SSAP[68] or Pro-Terra[69]. According to Schmidt & De Rosa (2020) cultivating palm oil following the RSPO certification standard can lead to **a lower nature occupation** of about 20% with respect to uncertified fields. Many of these vegetable fats (e.g. palm oil) are used as ingredients for the so called **ultra-processed food** (UPFs), both plant- and meat-based. UPFs represent a controversial food group, since they have been associated with poor health and social outcomes. Anastasiou et al., (2022) claim that plant-based UPFs might also have a significant negative impact on **phosphorus use, energy inputs and land use** (mainly due to the use of palm oil and soybeans as ingredients). According to Aceves-Martins et al., (2023), ready meals had significantly higher GHG emissions than home-cooked meals up to the supermarket shelf, with cooking adding further GHG emissions, depending on the cooking method. Animal-based oven-cooked ready meals are found to have the highest levels of GHG emissions.

— Criterion "Fair and ethical trade products"

This criterion focuses on products that are imported from developing countries and that often deal with social/labour standards lower than the EU minimum ones. This criterion requires a minimum of 90% of content with fair and ethical trade certification. Coffee, tea, sugar, chocolate and bananas

[63] https://www.gazzettaufficiale.it/eli/gu/2020/04/04/90/sg/pdf
[64] https://www.wien.gv.at/umweltschutz/oekokauf/pdf/fische-empfehlungen.pdf
[65] https://rspo.org/
[66] https://poig.org/
[67] https://responsiblesoy.org/?lang=en
[68] https://soygrowers.com/key-issues-initiatives/key-issues/sustainability/soybean-sustainability-assurance-protocol-ssap/
[69] https://www.proterrafoundation.org/

represent the most common imported products that are covered by responsible or ethical labels. As illustrated by the analysis of MINTEL database carried out by Sanyé Mengual et al., (2024b), currently, out of 210 mapped, there are 102 logos that cover multiple dimensions of sustainability (environment and social). These labels usually also include minimum environmental considerations, such as avoiding unsustainable **deforestation** and/or to restrict the use of hazardous **pesticides,** having a positive impact for **climate change**, **biodiversity and ecotoxicity.** According to (Willemen et al., 2019) and Pico-Mendoza et al., (2020), sustainable labels have positive effects in contrasting soil erosion (in coffee and tea farms). Furthermore, Hardt et al. (2015) show that certified coffee farms have more native vegetation cover than non-certified ones.

— Criterion "Plant-based menus"

Available literature (Cerutti et al., 2018; Springmann et al., 2018; Tregear et al., 2022) demonstrate how a reduction of meat consumption has a **high carbon footprint reduction** potential. Plant-based diets have been identified to have lower environmental impacts not only for climate change, but also for **PM2.5 pollution burden** (Balasubramanian et al., 2021). Regarding the impact on **eutrophication**, as stated in Xue & Landis (2010), red meat has the highest eutrophication potential, followed by dairy products, chicken/eggs and fish. A shift towards plant-based diets would then have a positive impact. The impact on **water use** due to a shift towards a more plant-based diet would depend on different production techniques and on the different geographical areas (Aleksandrowicz et al., 2016; Zucchinelli et al., 2021). The EAT lancet and the Food-Based Dietary Guidelines (FBDGs) are considered as an example of healthy and plant-based diets. In these two cases, meat and meat products are mostly substituted by nuts consumption. As showed by Aceves-Martins et al., (2023), reductions in environmental impact related to a lower consumption of animal products (and sugar) can be offset by increased environmental impacts related to greater consumption of nuts and legumes. According to their estimates, staying within the planetary boundary for water use can be achieved by combining improvements in water-use efficiency with reductions in food loss and waste. Furthermore, it is important to consider that some crops are heavily irrigated in some areas and not in others (Vanham et al., 2020). The choice of how/how much irrigating and which products to use to substitute meat products also plays a key role in the water use impact. Overall, higher requirements of irrigated crops would possibly increase the overall water consumption (Röös et al., 2022; Seufert & Ramankutty, 2017). Regarding **biodiversity**, as stated in Machovina et al., (2015) humans' negative impact can be significantly reduced by reducing demand for animal-based food products and increasing proportions of plant-based foods in diets. An increase in **food waste** generation is expected mainly due to: i) fruits and vegetables are the most wasted food categories at consumer level both due to consumers' acceptance, and as there might be an increase of food waste at preparation stages due to for example, peeling and cutting; ii) more fruits and vegetables consumption in terms of mass are needed in order to provide nutritional values closer to the ones included in animal products. Current data shows that 40% of food waste generated in the EU27 at consumer level is associated with fruit and vegetable food categories, while 10% for meat. There are already some preliminary studies from the US (Conrad & Blackstone, 2021; Conrad et al., 2018) analysing this trade-off between encouraging a healthy dietary pattern and the possible increase in the amount of food waste. These results are supported by the modelling exercise performed in this study in Section 7.2.2.

— Criterion "Food and beverage waste prevention"

Food waste, in developed countries, comes mostly from the post-consumer stage (food considered avoidable and suitable for consumption), as a result of an overly restrictive food quality control and miscommunications between producers, retailers, and consumers (Sadhukhan et al., 2020). The GPP criterion "Food and beverage waste prevention" addresses this impact category. Several examples of GPP practices including targeting waste reduction or better sorting as well as food waste prevention are available (see Section 6.2), but quantitative results are still hard to come by, as monitoring and evaluation is something that is not often addressed in this field. A feature that was highlighted in the desk research on GPP practices is how GPP is often taken up at city level, which can highlight how

GPP can link procurement to other local sustainability strategies. In the Recommendations for Action in Food Waste Prevention Developed by the EU Platform on Food Losses and Food Waste[70], some actions focused on the development of Guidelines, under the “improve action design, monitoring, evaluation and knowledge sharing regarding food waste prevention interventions” as well as the dissemination of guidelines to raise awareness and support stakeholders running food waste prevention actions. Even if, from a stakeholders’ perspective, they could thus be useful, no evidence on use of these guidelines has been found in the GPP sector uptake.

— Criterion “Other waste: prevention, sorting and disposal”

This criterion directly addresses **waste generation** (together with “Reusable cups” and “Chemical products and consumable goods”). GPP criteria promote common practices to encourage waste prevention and better sorting and disposal, both for accurate management and for customer awareness. Some examples of criteria are accurate inventory keeping, routine measurements, portion adjustments and awareness raising. In general, waste prevention represents the most desirable option, followed by material recovery/recycling and by energy recovery from waste (through incineration, or digestion of biodegradable wastes). The results of the desk research on best practices provided few examples of implementation of GPP criteria to counter waste generation, with generally positive outcomes (see Section 6.2), with a particular benefit for **climate change**.

— Criterion “Chemical products and consumable goods”

As explained in (Boyano et al., 2019), this criterion aims at reducing the use of chemical products and consumable goods and at reducing the environmental impacts of both chemical products and consumable goods whenever used. Requirements to avoid overdosing (e.g. kitchen roll, kitchen paper and dispensers) can have a positive impact on **waste generation**. Furthermore, a more accurate consumption of cleaning agents and hand soaps can have a positive impact also on eutrophication and **ecotoxicity** (Chirani et al., 2021).

— Criterion “Energy and water consumption in the kitchens”

This criterion aims at minimizing energy and water consumption by acting on ovens, hobs, dishwasher and refrigerated appliances. Energy use has an impact on several categories, such as **climate change** and **ozone depletion,** but of course the extent of its impact strictly depends on the fuel/source of the energy (Bilgen, 2014). Regarding **water use**, even if this criterion is aiming at minimizing water use, its contribution to the overall impact might be very minor, since almost 70% of global freshwater is used at primary production stage (that is, for irrigation and livestock production) (Foley et al., 2011; (WWAP UNESCO World Water Assessment Programme, 2019). The relevance of water use outside primary production might depend on the food product as shown in García-Herrero et al., (2023). The IEEA study (IEEA, 2012) showed that around 40% of the energy consumption of the kitchen is used for cooking, 28% for refrigeration, 17% at fumes extraction equipment and 5% at dishwashing.

— Criterion “Food transportation”

This criterion aims at reducing fuel consumption and air pollutant emissions. The importance of the role of transport on the life cycle of food is extensively debated in the literature: some studies consider transportation as a key element to achieve a more sustainable food consumption, for others the impact of long distances is less relevant. According to Crippa et al., (2021), **GHG emissions** from transportation make up a very small amount of the emissions from food. The impact of transport is small for most products, with the exception of transport by air, which is usually used for highly

[70] https://food.ec.europa.eu/system/files/2021-05/fs_eu-actions_action_platform_key-rcmnd_en.pdf

perishable products, like many fruits and vegetables. Therefore, the type of food product[71] is more important than the modality in the resulting impact of consumption patterns.

In this regard, also 'eating local', which is a frequent recommendation in GPP, represents a very popular and controversial topic. However, a local supply chain of a given product might only be better than the average conventional supply chain (which might be also globalized) depending on the entire life cycle of the product, and the output might depend on a case-by-case basis (Edwards-Jones et al., 2008). For example, with respect to GHG emissions, "eating local" would only have a significant impact if transport was responsible for a large share of food's final carbon footprint – which is not the case for many product groups. Local food purchase can be associated to reduced "food miles", however this metric focusing on distribution overlooks environmental hotspots along the entire life cycle. Furthermore, there are concerns on the need to ensure compliance with Directive 2014/24/EU and Directive 2014/25/EU. This topic will be further discussed in Section 6.3.4.

— Criterion "Reusable cups"

This criterion aims at reducing **waste generation**, especially of plastic and paper, which are common materials used for vending machines cups. For cups, the material and waste treatment at the end of life can lead to very different impacts on the environment. In general, reusable cups have a considerable environmental gain compared to the disposable ones, especially if cups are washed after more uses (instead of being washed after every use) (Potting & Van Der Harst, 2015; Van Der Harst et al., 2014).

— Criterion "Provision of low impact drinking water"

This criterion aims at reducing **waste generation**, especially of plastics and glass, which represent the main material used for bottled water. As demonstrated in Fantin et al., (2014), analysing the comparison between tap and bottled water considering their Global Warming Potential (GWP), tap water has always a better environmental performance, even in case of the high energy-consuming technologies for drinking water treatments. Plastic bottles, caps and lids are the most common Single Use Plastic (SUP) items of all SUP that can be found on beaches (macroplastic generation), causing transport of invasive species (rafting), microbial contamination and also a negative economic impact on tourism (European Commission, 2018).

— Criterion "Purchase of new kitchen equipment and vehicles"

This criterion aims at reducing **energy** consumption, with a particular benefit for **climate change** and **particulate matter**, due to the associated emissions of CO_2, SO_x and NO_x (Martins et al., 2019). However, the extent of the impact strictly depends on the fuel/source of the energy.

[71] According to Sanyé Mengual & Sala, (2023), animal-based products are those contributing the most to the overall EU food consumption footprint.

6 What are the environmental effects of GPP implementation?

6.1 Main findings

To assess the environmental impacts in GPP implementation, a literature review was carried out. The online database Scopus[72] was used as main source.

The first step of the review focused on the impacts analysed for the Consumption footprint model (see Table 2 for the list of impact categories) the keywords used were "GPP" AND "Public" AND "Procurement" AND each environmental impact category. The total output of the search amounted to 25 documents. After a first analysis, based on the study title, abstract and keywords, only 2 papers were selected. The remaining papers were not considered further due to:

- consideration of other GPP categories (e.g. construction and demolition);
- lack of data regarding environmental impacts (e.g. even if considering food and catering services, there were no data on the environmental impacts).

The two papers that were considered for further analysis are Cerutti et al., (2018) and Lindström et al., (2020). Lindström et al., (2020) show that public organic food purchases can be associated with a significant positive impact on organic farmland. In their study, they analyse the effect of the GPP policy decided in 2006 by the Swedish Government, stating that the public sector should increase its organic food consumption to 25% in order to contribute to a national goal of 20% organic farmland by 2010[73] (this policy was further improved in 2017, setting the new target of 30% by 2030[74]). Analysing data on organic farmlands with feasible generalized least squares estimation, they calculated that the mean county share of organic farmland increases from 6.9% in 2003 to around 19.8% in 2006, also thanks to direct subsidies aimed at organic production. Cerutti et al., (2018) proved that the most effective public procurement policies to reduce environmental impacts are those affecting the production phase, although they note that the GHG emissions of this phase are subject to a high uncertainty. The authors analyse the carbon footprint (CF) of the school catering service in the city of Turin (Italy). By adopting a life cycle approach, they first assess the CF of the baseline scenario and then analyse the effect of eleven GPP policies (divided by for four different modules: i) food production, ii) transport, iii) cooking, storage and serving; iv) waste management). Among the eleven selected policies, a change in diet towards a plant-based diet was found to be the most effective one(leading to a 32% reduction of the CO2eq emissions), followed by the adoption of improved food production practices (11% reduction) and the purchasing of certified green electricity (6% reduction).The second part of the literature review focused on other aspects related to GPP environmental impacts. The literature was retrieved from the Scopus database using the search string "Green AND Public AND Procurement AND food" and the following keywords "sustainability, ecosystem, biodiversity, environment". 36 documents were retrieved. After a first screening (study title, abstract and keywords), 21 studies were further analysed. Only three papers presented environmental impacts: Cerutti et al., (2018) -already described in the paragraph above- Smith et al., (2016) and Tregear et al., (2022). Smith et al., (2016) analyse five public sector food procurement case studies: Malmo (Sweden), Rome (Italy), Copenhagen (Denmark), Vienna (Austria) and East Ayrshire (Scotland). According to their study, the city of Vienna, thanks to its 'EcoBuy' programme (focused on organic food procurement) saved € 44.4 million and over 100,000 tonnes of CO_2 between 2001 and 2007. While in East Ayrshire, prioritizing unprocessed, local and a higher proportion of organic ingredients for school meals, lead to saving 37.7 tonnes CO_2 (annually), especially thanks to transport/distribution saving. Tregear et al., (2022) considered for their study five case studies of primary school catering from the following European countries: Croatia, Greece, Italy, Serbia, and UK.

[72] www.scopus.com
[73] https://www.regeringen.se/rattsliga-dokument/skrivelse/2006/03/skr.-20050688
[74] https://www.regeringen.se/rattsliga-dokument/proposition/2017/01/prop.-201617104

They demonstrate that, in terms of which activities reduce the most carbon emissions, waste disposal and reducing proportions of ruminant meat were the most relevant ones.

The remaining papers focused on different aspects related to the GPP for food and catering services, and more specifically:

- the factors influencing organic food purchase in public procurement and the relevance of organic products: Bucea-Manea-Toniș et al., (2021) highlight the role of farmers' associations and governmental subsidies to support GPP measures applied in organic agriculture in Romania. Filippini et al., (2018) analyse the factors that mostly affect the increase of organic food in Northern Italy schools, such as pressure from municipal, canteen committee for environmental sustainability and a territorial network for a better cooperation with local stakeholders. Kowalska & Bieniek, (2022) identify GPP as a valid tool to support the development of organic agriculture in the EU;
- the analysis of the most used GPP criteria: Neto & Gama Caldas, (2018) analyse 21 European public procurement schemes for food services at different level (national, regional, municipal and school level). According to their study, public procurement schemes focus on two main aspects: the type of food products (organic and certified products, seasonal, packaging) and the service provision (staff training, waste management, menu planning). The literature review on public procurement done by Molin et al., (2021) suggests that at global level, studies mostly focus on food waste and organic food, together with buying local and seasonal food;
- social and legal aspects of GPP (Schebesta, (2018); Krivasonoka, (2017); Wielicka-Regulska, (2020); Mikkselen et al., (2020)).

6.2 Examples of GPP practices

The third part of the review focused on GPP practices as an example of how public authorities in Europe have 'greened' a public tender or procurement process.

Two examples of GPP practices have been identified concerning waste generation, which is connected to existing GPP criteria. The first one has been retrieved from the World Economic Forum[75]: as part of its green public procurement, the Council in Hamburg banned in 2016 the use of coffee capsules in public buildings due to the difficulty of being recycled (it should be noted that this product has generated controversy as it was left out of the Packaging and Packaging Waste Directive). The second case has been retrieved from the GPP News Alert[76]: The management of the waste treatment facilities in the city of Sarpsborg was given to the contractor meeting minimum environmental and social requirements. Positive results were reported in terms of environmental impact reduction and social impacts.

Table 19 illustrates further examples of GPP Good practices[77] that reported quantitative data. According to the analysis, the measures mostly considered by public local authorities are focused on food waste reduction and on local food purchase (Figure 11).

[75] https://www.weforum.org/agenda/2016/03/a-german-city-just-became-the-first-in-the-world-to-ban-single-use-coffee-pods/
[76] https://ec.europa.eu/environment/gpp/pdf/news_alert/Issue72_Case_Study_145_Sarpsborg.pdf
[77] https://ec.europa.eu/environment/gpp/case_group_en.htm

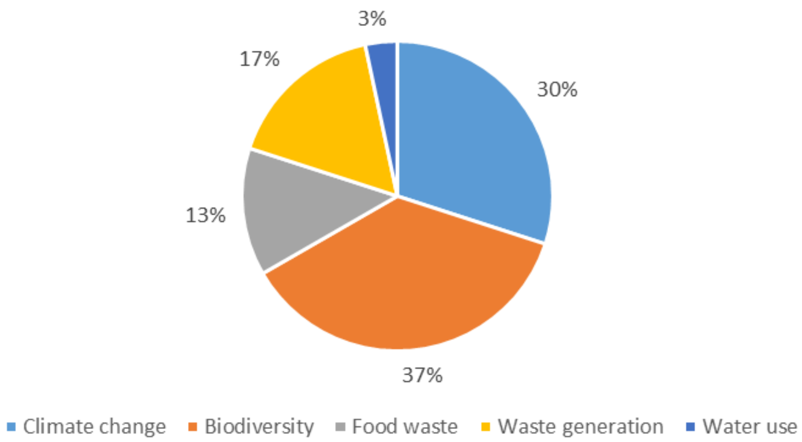
Table 19. GPP Good Practice examples with quantitative assessment.

GPP Good Practice examples	Country	Year	Achievements	Impact categories
Providing sustainable food at wholesale level for schools and elderly care homes	Sweden	2020	CO_2 emissions per kg of purchased food has been reduced to 1.5 CO_2-eq/kg in 2019. A more ambitious target has been set in Helsingborg`s Climate and Environmental plan of 1.1 CO_2-eq /kg food	Climate change Waste generation Food waste
Increasing the share of organic food in public canteens – one egg at a time	Sweden	2019	The city estimates that 175 tonnes of CO_2 emission savings have resulted from using a local food consolidation centre, in combination with using a high-quality transport car fleet fuelled with Hydrotreated Vegetable Oil (HVO), a synthetic diesel fuel which lowers CO_2 emissions further	Climate change Biodiversity
From the tap: replacing single-use water containers with glass in the Basque Country	Spain	2019	147,000 plastic cups, 4,000 big plastic water cooler bottles, and 7,000 small plastic bottles will be saved annually	Waste generation Water use
Preparation and delivery of healthy and sustainable school meals	Belgium	2019	In 2010, the percentage of food wasted fell from 28.7% in December 2010 to 13.2% in June 2011. The average percentage of food waste per year has continued to fall, from 19.9% in 2010-2011 to 11.2% in 2017-2018.	Food waste Biodiversity
Circular catering services for the Pļaviņu Gymnasium	Latvia	2018	This procurement could reduce the amount of food waste generated from the school canteens, as well as plastic waste by avoiding single-use dishes. Food waste could be reduced by 50-70%, depending on the starting point.	Food waste Biodiversity
Monitoring low carbon, sustainable catering services	Italy	2014	The requirement to provide food from integrated and organic production resulted in a reduction of 66.1 tCO_2 equivalent (about -26% of the carbon footprint of the whole supply chain of potatoes, carrots, apples, pears and peaches) compared with providing the same amount of food from conventional agricultural systems. The transportation of these five foods from the farm gate to the table accounted for between 5% and 25% of the carbon footprint	Climate change Biodiversity
A 100% Organic Canteen Without Extra Costs	France	2010	Implementation in all organic public procurement plans of the criteria of food waste reduction. Results show a reduction of plate waste of 80% over a 5 year period thanks to a variety of interventions including the offer of two sizes of portions, on-demand preparation of food and educational activities. The substantial reduction of waste led to a decrease in the average cost of the meal which compensated the extra costs associated with all-organic purchasing. Local organic	Food waste

			procurement and waste reduction in public catering.	
Sustainable food procurement for schools	Italy	2010	Based on the amount of meat served in the schools of the city of Rome (maximum of twice a week), approximately 8,887 tonnes of CO_2 eq. are emitted in an annual school year. Savings in water consumption associated with the reduced consumption of meat have been estimated at 5,783 m^3 annually. Plates and other serving utensils are made of reusable material, resulting in savings estimated at 1,800 tonnes of plastic over an annual school year.	Climate change Waste generation
Sustainable Food for Thought in Malmö (INNOCAT)	Sweden	2007	5% reduction in emissions	Climate change

Source: Own elaboration

Figure 11. Main environmental topics covered by GPP Good Practices.



Source: Own elaboration

6.3 What is the effect of GPP criteria implementation on food consumption?

The collected literature was also explored to understand the potential effects on environmental impacts due to changes in food consumption patterns resulting from GPP criteria. Public procurement can indeed be a key game changer for food system transformation: it can influence both food consumption and food production patterns, and has the possibility to deliver multiple social, economic, and environmental benefits towards sustainable food systems for healthy diets (WHO, 2022). Current GPP criteria can have an influence on dietary patterns, consumption of **organic** and **certified** food products, and consumption of **local food.**

Dietary patterns depend on many factors: income, prices, individual preferences and beliefs, cultural traditions and other elements, like geographical and environmental factors. Current GPP criteria include the promotion of plant-based products in catering menus, which could therefore **enhance a transition towards more sustainable and healthier consumption patterns**. Such changes can entail, for example, a higher presence of plant-based products in substitution of animal-based products or the reduction of the consumption of unhealthy products (e.g., ultra-processed options, products rich in salt, sugar).

Dietary changes towards sustainability can have impacts on different dimensions:

- (Public) Health, e.g. tackling the rise in non-communicable diseases, overweight, obesity, food safety. This can result from direct changes in diet (e.g., reducing fat consumption) or indirect effects due to improving environmental impacts (such as health impacts associated to climate change).
- Economical, e.g., employment and trade opportunities. (Donati et al., 2016) confirm that a sustainable diet is not more expensive than the current diet. Furthermore, the analysis carried out by (Rieger et al., 2023) shows that the changes in production due to the shift towards more sustainable diets (specific case of EAT-Lancet) are smaller than those in demand due to international trade effects, and that the agricultural sector in the EU-27 could benefit from a dietary shift, while the results are mixed at the country, regional, or farm level.
- Social, e.g. supporting better lifestyles (Johnston et al., 2014), access to good food for all.
- Environmental, e.g. reducing climate change impacts of current diets through substituting animal-based products with plant-based alternatives or certified food (e.g. organic or certified sustainable products), which have a positive impact on many environmental aspects such as biodiversity, soil quality and ecotoxicity. A reduction in food waste also plays a key role in reaching more sustainable food production and consumption.

Given their relevance, four aspects related to the effect of GPP on food consumption have been analysed more in detail: the consumption of **ultra-processed food products** (6.3.1), **plant-based products** (6.3.2), **organic and certified products** (6.3.3) and **local products** (6.3.4).

6.3.1 Reducing the consumption of ultra-processed food products

The consumption of **ultra-processed food (UPF)**, which is known to be high in energy content and low in beneficial nutrients, has increased in the past years. In Europe, the consumption of UPFs varies substantially ranging from 14% in Italy and Romania to 44% in Sweden (or the UK) (Mertens et al., 2022). Reducing the consumption of ultra-processed food may bring to the reduction of some environmental impacts (e.g., GHG emissions, energy use, land use) (Anastasiou et al., 2022). A study carried out in Brazil has shown that, from 1987–88 to 2017–18, the contribution of UPFs to daily environmental impacts (gas emissions, water footprint, and ecological footprint) per individual at least doubled, reaching about 20% of the total diet-related footprints (Da Silva et al., 2021).

6.3.2 Increasing the consumption of plant-based products

The shift towards **more plant-based diets** can represent a substantial contribution to a more sustainable food system, having a positive effect on many environmental impact categories, as explained in Section 5. The comparison between the current diet, the EAT-Lancet diet and the FBDGs diet (see Section 7, Table 7) illustrates that shifting towards a healthier diet would imply a higher consumption of cereal-based products, legumes, nuts and vegetables, and a strong reduction in animal-based and confectionary products. Currently, meat consumption is growing at global level, while at European level it is slowly declining (although in some countries the trend is still positive (Godfray et al., 2018)). Animal-based products currently represent around 70% of the environmental impacts of EU food consumption (Sala et al., 2023). As previously mentioned, a diet based on more plant-based products would have a positive effect for climate change (Behrens et al., 2017; Cerutti et al., 2018; Tregear et al., 2022; Springmann et al., 2018), ozone depletion, particulate matter (Balasubramanian et al., 2021), eutrophication (Xue & Landis, 2010), ecotoxicity (Nordborg et al., 2017), biotic resources. Trade-offs have been identified for a few impact categories such as water use and food waste (for the impact on food waste see Section 7.2.2).

6.3.3 Increasing the consumption of organic and certified products

Current GPP criteria can have a great influence also on the production (and consumption) of **organic** and **certified** food products, which are associated to positive effects on the environment. On one side, some studies have observed a link between criteria in public procurement promoting organic products and the demand of organic food products. Lindström et al., (2020) demonstrated how public organic food purchases can be associated with a significant positive impact on organic farmland and also Sørensen et al., (2016) report significant increases in the percentage of organic food procurement in Denmark. According to Sørensen et al., (2016), in terms of national impact on organic food production, the increase in organic public procurement observed in Denmark could continue over time as the sample size of 622 out of approximately 6000–10000 public kitchens in total in Denmark can be considered relatively large. On the other side, one of the major barriers associated with organic products consumption is related to their affordability. To maximize organic consumption among children, complete meals should be served in school paid for by the public, thereby with strong public involvement (Strassner et al., 2015). In Finland, caterers as well as consumers are often confronted with the fact that organic products are neither easy to find nor affordable, and quality problems have been reported (since food free from synthetic food additives tend to spoil faster) (Risku-Norja & Løes, 2017). Simón-Rojo et al. (2020) stated that given the weak presence of organic production in the region of Madrid (Spain), public food procurement will fail to drive job creation, innovation, and environmental sustainability if it is not accompanied by measures addressing the supply sector.

6.3.4 Prioritizing local food products

Another important aspect to mention when referring to public procurement and food consumption is the role of **local food**. There is no official definition of how close to the consumer a food product must be produced to be called 'local' or 'locally produced' (Granvik et al., 2017). Local food purchase can be associated to reduced food miles, with positive environmental benefits. However, there are concerns on the need to ensure compliance with Directive 2014/24/EU and Directive 2014/25/EU. There are already procurement organizations that have internal targets for locally or locally produced food in the public kitchens:

- Hungary: from 2023, contracting authorities will be obliged to insert local products as contract performance clause[78].
- Austria: the forum "Austria eats regionally" focuses on the provision of regional and seasonal food, based on the existing specifications for food and catering services[79].
- Latvia: according to Simanovska et al., 2020, local food (specified distance from the place of origin) is used as award criterion (the same happens for Italy[80]).

From an environmental perspective, Ritchie & Roser, (2022) reports that 'eating local' is a frequent recommendation for food purchase with respect to GHG emissions; however, it would only have a significant impact if transport was responsible for a large share of food's final carbon footprint. However, this is not the case for most food products. GHG emissions from transportation make up a very small amount of the emissions from food and the type of food consumed is far more important than its modality (Ritchie & Roser, 2022); Cerutti et al., 2018). The impact of transport is small for most products, with the exception of transport by air or long refrigeration storage needed (Webb et al., 2013). Products transported by air are usually highly perishable, like many fruits and vegetables.

[78] 5.1 Update Members GPP AG_final.pdf (europa.eu)
[79] https://www.nabe.gv.at/wp-content/uploads/2021/06/naBe-Aktionsplan-2020.pdf
[80] https://www.gazzettaufficiale.it/eli/id/2020/04/04/20A01905/sg

Whether a local food product is better than the global market one might depend on the single case, as the production processes (e.g., heated greenhouses) and logistics (e.g., air transport) might determine the best option (Edwards-Jones et al., 2008). Consuming only locally-produced food does not guarantee the environmental sustainability of food products; the agricultural production methods (e.g. conventional or organic) and whether production occurred in a field or, for example, in a greenhouse with temperature control through the use of fossil fuels are factors that must be considered (Coelho et al., 2018). In addition, local food systems may require more intensive practices to satisfy the local demand and this could lead to higher environmental stresses (Pradhan et al., 2015).

Beyond the environmental dimension, many studies illustrating measures adopted by public authorities highlight that supporting the purchase of local food could have beneficial effects for local communities (Swensson & Tartanac, 2020). Finally, in terms of social sustainability, local food systems cannot ensure food security alone, but they can contribute to rural development and creating a sense of community (Stein & Santini, 2022).

7 How might environmental impacts of EU food consumption change due to GPP and SPP implementation?

This section presents the results of modelling exercises to further explore potential environmental impacts of GPP and SPP implementation: the comparison of organic to conventional products, to provide an indication on the impacts of GPP implementation (section 7.1); the comparison of the environmental impacts of three different diets (current, FBDGs and EAT-Lancet), to provide first indications on possible SPP implementation (Section 7.2); and possible environmental impacts of GPP and SPP implementation, by combining the expected uptake level of GPP (organic products) and SPP (diet change) (Section 7.3).

7.1 GPP implementation: what are the effects of promoting organic food products?

The environmental impacts of organic products compared to conventional products in different impact categories are presented in Table 20 (in terms of ratio organic/conventional). Trade-offs exist for specific products and impact categories, i.e., some impact categories show lower impact for organic products, while in some impact categories organic products have higher impact. Such trade-offs are associated both to a lower efficiency of organic production (e.g., larger land use) and to different agricultural practices (e.g., fertilizers). This is noticed also in previous studies, e.g., Boschiero et al., (2023), Seufert & Ramankutty, (2017) and Tuomisto et al., (2012) have concluded that organic products usually have lower impacts per hectare, but when comparing impacts per mass, organic products do not always have lower impacts because of lower yields.

Organic apples and potatoes have mostly higher impacts than conventional ones. However, in some impact categories the performance is in the same level, i.e. in Climate Change, Ozone Depletion and Freshwater Eutrophication for both products, and in case of potato also in Water Use and Ecotoxicity. This higher impact of organic production is mainly due to lower yields (the organic apple and potato yields are, respectively, 55% and 52% of conventional ones, Table 21), but also due to different types of fertilisers and plant protection products. For example, the ecotoxicity impact of organic apples is twice the one of conventional apples. The main contributing flow is sulphur to soil from sulphur-based plant protection products, which is not used in conventional agriculture. Also, organic fertilisers, such as cow manure or pig slurry, which naturally contain heavy metals (e.g. zinc, lead, copper and cadmium), may provoke toxicity impacts (Boschiero et al., 2023). The Water Use impact of organic apples is more than double compared to conventional apples, because the irrigation amount is almost the same in both cases (organic: 2684 m^3/ha; conventional 2691 m^3/ha), while the conventional apple yield is almost double compared to organic apple.

In case of rice and orange, the conventional process was modified to represent organic production (see section 3.3.2). In that case, yield and nitrogen input was kept constant and the modifications affected fertilizer type (substituted) and pesticides use (removed). This leads to lower ecotoxicity impacts, but higher or slightly lower impacts in all other impact categories. In the case of rice, impacts on Ozone Depletion and Resource Use, minerals and metals impacts are significantly higher, because of the raw materials used and transported to composting facilities. However, for oranges these impacts are lower or at the same level with conventional ones, because the nitrogen use per kg orange is not as high as for rice.

Organic broccoli, beans and chickpeas have similar or even slightly higher yield compared to conventional ones (Table 21) and, thus, also environmental impacts are mainly lower or in the same level. Again, Ozone Depletion and Resource Use, minerals and metals impacts are higher for organic products compared to conventional ones. Also, organic tomatoes and carrots have lower impact in almost all impact categories although their yield is lower compared to conventional ones.

In the case of pork and poultry meat, as well as eggs, the organic cultivation data used considered also a change in the feed type from conventional to organic. This change influenced the amount of feed and water consumed per kg of produced meat (i.e., higher for organic meat). For cattle beef meat and milk, the situation is more complex due to different types of diets for organic and conventional animals. For example, dry hay is included in the diet of organic animals although not for conventional ones. This might affect differently the considered impact categories.

Table 20. Environmental impacts of organic products compared to conventional products in different impact categories (ratio organic/conventional).

	CC	ODP	PM	TEU	FEU	MEU	WU	LU	MRD	ECOTOX
Apples	105%	100%	109%	143%	103%	209%	225%	149%	121%	201%
Oranges	127%	100%	99%	99%	97%	108%	100%	115%	84%	80%
Potato	102%	101%	111%	119%	102%	123%	102%	187%	112%	100%
Rice	152%	205%	133%	124%	119%	116%	102%	133%	222%	30%
Bread	101%	124%	217%	253%	105%	164%	99%	25%	123%	66%
Pasta	99%	84%	179%	212%	98%	193%	55%	5%	71%	95%
Broccoli	92%	106%	54%	52%	83%	50%	91%	88%	137%	59%
Carrots	101%	122%	66%	58%	98%	59%	124%	97%	151%	117%
Chickpeas	66%	108%	79%	73%	106%	143%	60%	83%	103%	53%
Beans	92%	123%	42%	42%	46%	74%	86%	93%	122%	45%
Tomato	81%	100%	31%	57%	80%	69%	73%	37%	116%	72%
Pork	105%	102%	133%	139%	83%	121%	166%	279%	362%	32%
Poultry	66%	102%	114%	133%	77%	121%	194%	249%	266%	20%
Beef cattle	107%	114%	157%	160%	365%	42%	40%	786%	768%	61%
Beef dairy	224%	104%	135%	144%	74%	94%	163%	712%	453%	38%
Eggs	60%	118%	72%	81%	116%	115%	108%	199%	208%	51%
Milk	69%	104%	33%	33%	103%	35%	107%	214%	104%	81%
Cheese	71%	103%	31%	32%	106%	66%	123%	224%	159%	68%
Butter	63%	106%	30%	31%	128%	18%	130%	222%	204%	24%

Source: Own elaboration. Note: Green colour means the impact of organic product is lower, and red colour that impact of organic product is higher than conventional product. Similar impacts (±5%) are highlighted with yellow. The columns detail the environmental impact categories of the Environmental Footprint 3.0 method addressed: CC = Climate Change; ODP = Ozone Depletion; PM = Particulate Matter; TEU = Eutrophication – terrestrial; FEU = Eutrophication – freshwater; MEU = Eutrophication – marine; WU = Water Use; LU = Land Use; MRD = Resource Use – minerals and metals; ECOTOX = Ecotoxicity (freshwater).

Table 21. Comparison of organic and conventional crop yields (kg/ha).

Crop	Organic	Conventional	Ratio
Apple	22 041	40 000	0.55
Orange	30 000	30 000	1.00
Beans	3 384	3 160	1.07
Chickpeas	1 500	1 240	1.21
Broccoli	13 500	13 200	1.02
Carrots	42 500	58 400	0.73
Tomato	103 700	165 000	0.63
Potato	22 908	44 100	0.52

Rice	6 650	6 650	1.00
Wheat (for bread and pasta)	4 069	7 940	0.51

Source: Own elaboration

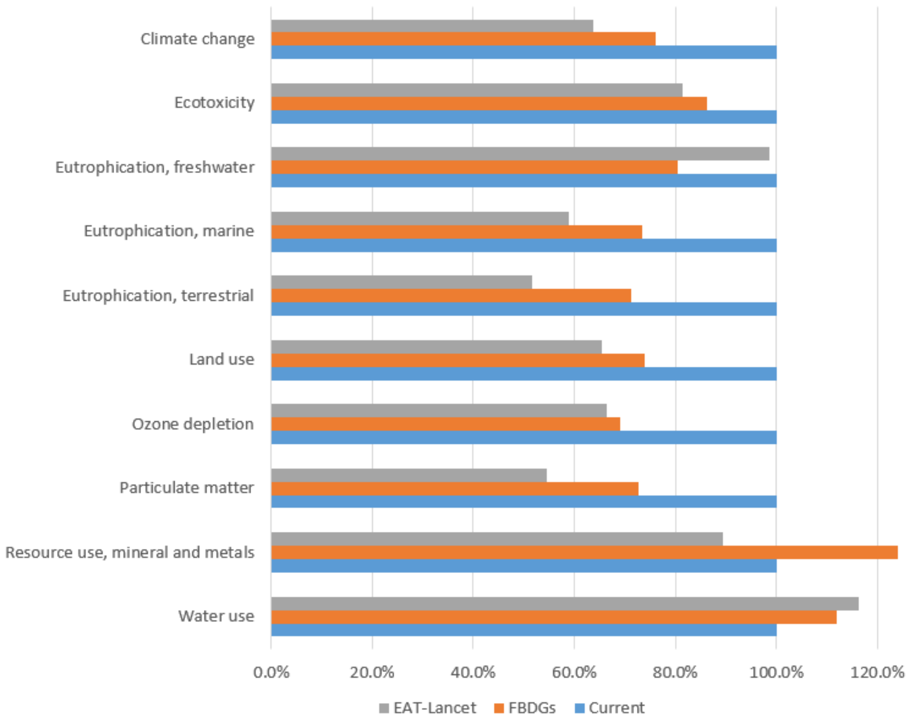
7.2 SPP implementation: what are the effects of a diet change?

This section presents the environmental and food waste impacts if Food-Based Dietary Guidelines (FBDGs) or EAT-Lancet Commission on Healthy Diets From Sustainable Food guidelines are applied instead of the average European diet.

7.2.1 Environmental impacts

Figure 12 presents the comparison of the current average diet with the diets aligned with the Food-Based Dietary Guidelines (FBDGs) in Europe (European Commission, 2019) and with the EAT-Lancet Commission on Healthy Diets From Sustainable Food (Willett et al., 2019). Changing the current diet would lead to environmental benefits in almost all impact categories, except in Water Use (both diets) and in Resource Use, minerals and metals (only FBDGs). Higher Water Use impact is mainly due to high amounts of nuts and seeds and (for EAT-Lancet) rice in the alternative diets compared to the current one (García-Herrero et al., 2023), which are highly irrigated. The higher impact in Resource Use, minerals and metals impact is mainly due to a higher consumption of canned legumes (and the associated metal required for the packaging). EAT-Lancet diet recommends a much lower meat (except for poultry) and milk consumption compared to FBDGs, red meat consumption being 30%-22% compared to current consumption levels, which leads to lower impacts in most of the impact categories.

Figure 12. Environmental impact of diet based on Food-Based Dietary Guidelines (FBDGs) in Europe and "EAT-Lancet Commission on Healthy Diets From Sustainable Food" compared to current average diet (set as 100%).



Source: Own elaboration

7.2.2 Food waste generation

To evaluate the impact on food waste of more sustainable and healthy diets (expected with the adoption of SPP criteria), the amount of food waste that could be generated by the consumption patterns stemming from the FBDGs and ET-Lancet diets have been quantified and compared with the current consumption pattern. Food waste coefficients are taken from De Laurentiis et al., (2021) and De Laurentiis et al., (2023) (Annex 6). **FBDGs diet increases the amount of food waste generated when compared to the current EU diet and EAT-Lancet alternative** (Table 22). The FBDGs diet generates 69 kg of food waste (per capita/year) more than the current EU diet, while the EAT-Lancet generates 6 kg less than the current EU diet (per capita/year). When considering only edible food waste, the value is also higher in FBDGs diets, with more than 54 kg of edible food being wasted per year/capita in the FBDGs diet and 6 kg less in the EAT-LANCET diet compared with the current EU diet. It is relevant to highlight that EAT-LANCET and the current EU diet include a higher amount of food and therefore more food waste is associated to them. When comparing the percentage of food wasted versus food provided, in the current EU diet and FBDGs around 22 % of the provided food is wasted, while in the EAT-Lancet, 24% of the provided food is wasted. These figures indicate that EAT-Lancet generates more food waste than the other two diets considering the among of food provided as reference.

Table 22. Total food provided, total food waste and edible food waste in kg per capita (absolute value and share of total food) of current, FBDGs and LANCET diets.

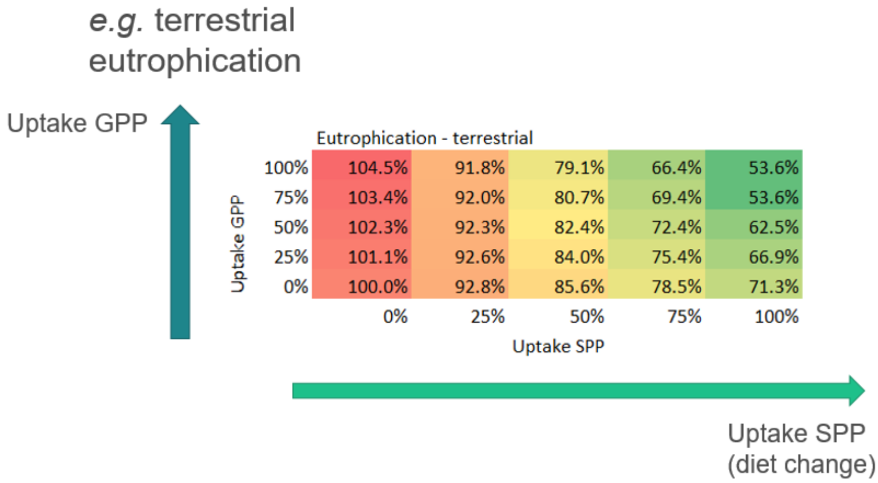
Diet	Total food provided	Total food waste		Edible waste	
	Amount (kg)	Amount (kg)	Share of total food provided (%)	Amount (kg)	Share of total food provided (%)
Current diet	631.15	140.61	22.28	116.38	18.44
FBDGs	948.81	209.17	22.04	170.69	17.98
EAT-LANCET	554.69	134.94	24.33	110.28	19.88

Source: (EC-JRC, 2022b; European Commission, 2019; Willett et al., 2019)

7.3 What are the combined effects GPP and SPP implementation?

This section presents the results of a modelling exercise assessing the combined implementation of existing GPP criteria (modelled as shift towards organic food products) and additional potential SPP criteria (modelled as diet shift). The analysis of GPP and SPP criteria implementation is performed by combining the expected uptake level of GPP (Section 7.1) and SPP (Section 7.2) by using the Consumption Footprint model. This results in a matrix of expected effects on the environmental impacts of EU food consumption that would depend on the uptake of both GPP and SPP. The GPP uptake level is used to model the consumption of organic food products, while the SPP uptake level is used to model the shift towards plant-based diets. An example is here provided for the terrestrial eutrophication impact category (Figure 13), highlighting the possible negative effect of increased consumption of organic products (however very limited, +4.5% with a maximum 100% GPP uptake) which can be strongly offset with the more significant reduction of the environmental impacts due to reducing animal-based products consumption (an almost 54% decrease with a maximum 100% SPP uptake).

Figure 13. Matrix on terrestrial eutrophication impact with respect to the GPP and SPP uptake.



Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	104.5%	91.8%	79.1%	66.4%	53.6%
75%	103.4%	92.0%	80.7%	69.4%	53.6%
50%	102.3%	92.3%	82.4%	72.4%	62.5%
25%	101.1%	92.6%	84.0%	75.4%	66.9%
0%	100.0%	92.8%	85.6%	78.5%	71.3%

Source: Own elaboration

In general, results show that higher GPP uptake does not necessarily lead to lower environmental impacts, because organic products can have higher per kg impact than conventional products in some impact categories, i.e. Ozone Depletion, Land Use, Water Use, Resource Use, and Freshwater and Terrestrial Eutrophication. This is usually because of lower yields in organic production, which can offset the benefits, but also different cultivation practices, as explained in Section 7.1 (Table 20). SPP implementation (diet change) shows positive effects in environmental impacts in most of the environmental impact categories, although potential trade-offs occur for some impact categories, such as Water Use (due to nuts cultivation), and Resource Use – minerals and metals (due to packaging of canned legumes). The more ambitious the healthy diet is in terms of reducing meat consumption, the more likely potential organic trade-offs can be offset partially (e.g., land use) or completely (e.g., terrestrial eutrophication or ozone depletion). An exception is water use, where water use impact in nuts cultivation (198% change in nuts and seed consumption as well as 185% change in rice consumption in EAT-Lancet diet) is higher than the impact of meat products and, thus, a diet change is showing a higher increase than that of a shift to organic product.

Implementing both SPP and GPP shows positive effects in most of the environmental impact categories[81]. The largest positive effect of an increased uptake of both GPP and SPP is observed for Climate Change, Ozone Depletion, Eutrophication – terrestrial, Eutrophication – marine, and Particulate Matter (e.g., theoretical maximum uptake of 100% for both GPP and SPP).

[81] This type of analysis could be employed to identify optimal uptake levels that minimize trade-offs. This is however out of the scope of this study.

Figure 14. Matrixes on GPP (y-axis) and SPP (x-axis) uptake for two different recommended diets regarding SPP: a) Food-Based Dietary Guidelines (FBDGs), and b) EAT-Lancet recommendations; by impact category.

(a) FBDGs

Climate Change

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	102.1%	95.1%	88.0%	80.9%	73.9%
75%	101.6%	94.8%	88.0%	81.2%	73.9%
50%	101.1%	94.5%	88.0%	81.5%	74.9%
25%	100.5%	94.3%	88.0%	81.7%	75.4%
0%	100.0%	94.0%	88.0%	82.0%	76.0%

Ozone Depletion

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	102.9%	94.9%	87.0%	79.0%	71.0%
75%	102.2%	94.3%	86.3%	78.4%	71.0%
50%	101.5%	93.6%	85.7%	77.9%	70.0%
25%	100.7%	92.9%	85.1%	77.3%	69.5%
0%	100.0%	92.3%	84.5%	76.8%	69.0%

Land Use

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	270.9%	239.3%	207.8%	176.2%	144.6%
75%	228.2%	202.9%	177.5%	152.2%	144.6%
50%	185.4%	166.4%	147.3%	128.3%	109.2%
25%	142.7%	129.9%	117.1%	104.3%	91.6%
0%	100.0%	93.5%	86.9%	80.4%	73.9%

Water Use

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	122.3%	124.2%	126.1%	128.0%	129.9%
75%	116.7%	118.9%	121.0%	123.2%	129.9%
50%	111.2%	113.6%	116.0%	118.4%	120.9%
25%	105.6%	108.3%	111.0%	113.7%	116.4%
0%	100.0%	103.0%	105.9%	108.9%	111.9%

Particulate Matter

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	99.4%	87.9%	76.4%	64.8%	53.3%
75%	99.6%	89.2%	78.8%	68.5%	53.3%
50%	99.7%	90.5%	81.3%	72.1%	63.0%
25%	99.9%	91.8%	83.8%	75.8%	67.8%
0%	100.0%	93.2%	86.3%	79.5%	72.6%

Ecotoxicity

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	103.7%	104.2%	104.7%	105.2%	105.7%
75%	102.8%	102.3%	101.8%	101.3%	105.7%
50%	101.9%	100.4%	98.9%	97.5%	96.0%
25%	100.9%	98.5%	96.0%	93.6%	91.1%
0%	100.0%	96.6%	93.1%	89.7%	86.3%

(b) EAT-Lancet

Climate Change

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	102.1%	92.3%	82.5%	72.6%	62.8%
75%	101.6%	92.0%	82.3%	72.7%	62.8%
50%	101.1%	91.6%	82.1%	72.7%	63.2%
25%	100.5%	91.3%	82.0%	72.7%	63.4%
0%	100.0%	90.9%	81.8%	72.7%	63.7%

Ozone Depletion

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	102.9%	94.1%	85.2%	76.4%	67.5%
75%	102.2%	93.4%	84.7%	75.9%	67.5%
50%	101.5%	92.8%	84.1%	75.5%	66.8%
25%	100.7%	92.2%	83.6%	75.0%	66.4%
0%	100.0%	91.5%	83.0%	74.5%	66.1%

Land Use

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	270.9%	231.9%	192.9%	153.8%	114.8%
75%	228.2%	196.7%	165.1%	133.6%	114.8%
50%	185.4%	161.4%	137.4%	113.4%	89.4%
25%	142.7%	126.2%	109.7%	93.2%	76.7%
0%	100.0%	91.0%	82.0%	73.0%	64.0%

Water Use

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	122.3%	124.4%	126.5%	128.6%	130.7%
75%	116.7%	119.2%	121.8%	124.3%	130.7%
50%	111.2%	114.1%	117.0%	119.9%	122.9%
25%	105.6%	108.9%	112.3%	115.6%	118.9%
0%	100.0%	103.7%	107.5%	111.2%	115.0%

Particulate Matter

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	99.4%	86.1%	72.8%	59.5%	46.2%
75%	99.6%	86.7%	73.8%	61.0%	46.2%
50%	99.7%	87.3%	74.8%	62.4%	49.9%
25%	99.9%	87.8%	75.8%	63.8%	51.8%
0%	100.0%	88.4%	76.8%	65.2%	53.7%

Ecotoxicity

Uptake GPP \ Uptake SPP	0%	25%	50%	75%	100%
100%	103.7%	99.0%	94.4%	89.7%	85.0%
75%	102.8%	97.9%	93.1%	88.3%	85.0%
50%	101.9%	96.8%	91.8%	86.8%	81.8%
25%	100.9%	95.7%	90.5%	85.4%	80.2%
0%	100.0%	94.6%	89.3%	83.9%	78.6%

Resource Use - minerals and metals

Uptake GPP					
100%	193.1%	205.9%	218.6%	231.4%	244.2%
75%	169.8%	180.9%	192.0%	203.1%	244.2%
50%	146.6%	156.0%	165.4%	174.8%	184.2%
25%	123.3%	131.0%	138.7%	146.4%	154.1%
0%	100.0%	106.0%	112.1%	118.1%	124.1%
	0%	25%	50%	75%	100%

Uptake SPP

Eutrophication - freshwater

Uptake GPP					
100%	198.8%	195.1%	191.5%	187.8%	184.2%
75%	174.1%	170.1%	166.2%	162.2%	184.2%
50%	149.4%	145.1%	140.8%	136.5%	132.3%
25%	124.7%	120.1%	115.5%	110.9%	106.3%
0%	100.0%	95.1%	90.2%	85.3%	80.4%
	0%	25%	50%	75%	100%

Uptake SPP

Eutrophication - marine

Uptake GPP					
100%	109.6%	101.9%	94.3%	86.6%	79.0%
75%	107.2%	99.8%	92.4%	85.0%	79.0%
50%	104.8%	97.7%	90.5%	83.4%	76.2%
25%	102.4%	95.5%	88.6%	81.8%	74.9%
0%	100.0%	93.4%	86.8%	80.1%	73.5%
	0%	25%	50%	75%	100%

Uptake SPP

Eutrophication - terrestrial

Uptake GPP					
100%	104.5%	91.8%	79.1%	66.4%	53.6%
75%	103.4%	92.0%	80.7%	69.4%	53.6%
50%	102.3%	92.3%	82.4%	72.4%	62.5%
25%	101.1%	92.6%	84.0%	75.4%	66.9%
0%	100.0%	92.8%	85.6%	78.5%	71.3%
	0%	25%	50%	75%	100%

Uptake SPP

Resource Use - minerals and metals

Uptake GPP					
100%	193.1%	190.7%	188.3%	185.9%	183.5%
75%	169.8%	167.6%	165.5%	163.3%	183.5%
50%	146.6%	144.6%	142.6%	140.7%	138.7%
25%	123.3%	121.5%	119.8%	118.1%	116.3%
0%	100.0%	98.5%	97.0%	95.4%	93.9%
	0%	25%	50%	75%	100%

Uptake SPP

Eutrophication - freshwater

Uptake GPP					
100%	198.8%	187.1%	175.3%	163.6%	151.9%
75%	174.1%	164.2%	154.3%	144.5%	151.9%
50%	149.4%	141.4%	133.3%	125.3%	117.3%
25%	124.7%	118.5%	112.3%	106.2%	100.0%
0%	100.0%	95.7%	91.3%	87.0%	82.7%
	0%	25%	50%	75%	100%

Uptake SPP

Eutrophication - marine

Uptake GPP					
100%	109.6%	99.4%	89.3%	79.1%	69.0%
75%	107.2%	96.9%	86.7%	76.4%	69.0%
50%	104.8%	94.4%	84.0%	73.7%	63.3%
25%	102.4%	91.9%	81.4%	70.9%	60.4%
0%	100.0%	89.4%	78.8%	68.2%	57.6%
	0%	25%	50%	75%	100%

Uptake SPP

Eutrophication - terrestrial

Uptake GPP					
100%	104.5%	89.9%	75.3%	60.6%	46.0%
75%	103.4%	89.4%	75.3%	61.3%	46.0%
50%	102.3%	88.8%	75.4%	62.0%	48.6%
25%	101.1%	88.3%	75.5%	62.7%	49.8%
0%	100.0%	87.8%	75.6%	63.3%	51.1%
	0%	25%	50%	75%	100%

Uptake SPP

Source: Own elaboration

8 Concluding remarks

This report collects data on the current uptake of GPP criteria for the food, catering and vending machines sector among EU countries, as well as on the effectiveness of possible Green Public Procurement (GPP) measures from an environmental perspective. Furthermore, it also evaluates the potential environmental impacts of Sustainable Public Procurement criteria (SPP).

The analysis was performed by designing a combination of qualitative and quantitative methods: extensive desk research, literature review and modelling.

This study was structured around four main questions.

What is the current uptake of GPP criteria in the EU and EU countries? A review of grey and scientific literature was performed to obtain data on GPP uptake (including the potential uptake of individual GPP criteria). It should be noted that data availability was significantly limited by the fact that GPP represent a voluntary measure and there is no monitoring system at EU level. Findings from literature show that there is a positive, but very heterogeneous, trend in GPP uptake across the years.

How are environmental impacts addressed in the GPP criteria? Current GPP criteria were analysed to identify in which life cycle stage effects might occur. All environmental impacts turn out to be addressed by at least one GPP criteria. Climate change and biodiversity loss were those addressed by the largest number of criteria. Current criteria focus mainly on primary production and consumption of food products.

What are the environmental effects of GPP implementation? A literature review was performed to retrieve information on possible effects of GPP implementation. A limited number of studies exist assessing the effects of GPP on case studies, while some countries report GPP Good practices. The effectiveness of the measures put in place is hard to estimate, since public authorities are free to set the thresholds for each criterion. Findings from literature show that countries and municipalities strongly support the purchase of organic and certified products, food waste reduction measures and plant-based menus for catering services. GPP can have indirect environmental effects due to direct changes in food consumption patterns such as promoting organic or certified food, plant-based diets or more healthy options (e.g., reducing UPFs). Such trends have associated environmental benefits which are substantiated by the literature.

How might environmental impacts of EU food consumption change due to GPP and SPP implementation? The Consumption Footprint model (Sanyé Mengual & Sala, (2023); Sala et al., (2023)) was used to quantify the potential changes in the environmental impact of the EU food consumption due to the uptake of GPP criteria (modelled as substitution of conventional food products by organic food products) and of SPP criteria (modelled as dietary change towards two recommended diets: FBDGs and EAT-Lancet). Results show that higher GPP uptake does not necessarily lead to lower impacts, while higher SPP intake leads almost always to lower impacts (trade-offs occur for food waste, resource use mineral and metals, land use and water use). Some of these trade-offs (e.g. food waste) could be tackled by specific actions. A shift towards plant-based diet represent the measure that could better shape both consumption and production stages towards a more sustainable food system.

Overall, GPP criteria represent an insufficient instrument since implementation remains voluntary and scope very narrow. More comprehensive food public procurement guidelines are advisable, with a focus on the three dimensions of sustainability (environmental, social/health and economic). In this respect, **SPP criteria can provide environmental benefits resulting from a wider uptake of environmental criteria** (e.g., climate change, biodiversity loss) **and from a promotion of plant-based diets that would have a positive effect in reducing environmental impacts**. SPP implementation would also benefit from monitoring schemes with the aim of enabling the quantification of actual effects on the environmental impacts of the EU food system.

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List of abbreviations

BoP	Basket of Products
CF	Carbon footprint
DG	Directorate General
EEA	European Environment Agency
ESTAT	Eurostat
EC	European Commission
EU	European Union
FAO	Food and Agriculture Organization
FBDGs	Food-Based Dietary Guidelines
F2F	Farm to Fork
GDP	Gross domestic product
GHG	greenhouse gas
GMO	genetically modified organism
GPP	Green Public Procurement
GWP	Global Warming Potential
IPP	Integrated Product Policy
JRC	Joint Research Centre
LCA	Life Cycle Assessment
MEAT	Most Economically Advantageous Tender
MIDAS	Modelling Inventory and Knowledge Management System of the European Commission
MS	Member State
NAP	National Action Plan
NOAA	National Oceanic and Atmospheric Administration
PFP	Public Food Procurement
SAPEA	Science Advice for Policy by European Academies
SDGs	Sustainable Development Goals
SPP	Sustainable Public Procurement
SUP	Single Use Plastic
UN	United Nations
UNEP	United Nations Environment Programme
UPF	Ultra-processed food
WHO	World Health Organization
WTO	World Trade Organization
WWF	World Wide Fund for Nature

Environmental Footprint impact categories

CC	Climate Change
ODP	Ozone Depletion
PM	Particulate Matter
TEU	Eutrophication – terrestrial
FEU	Eutrophication – freshwater
MEU	Eutrophication – marine
WU	Water Use
LU	Land Use
MRD	Resource Use – minerals and metals
ECOTOX	Ecotoxicity

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Annexes

Annex 1. Literature review supporting the mapping between environmental impacts, activities of the food system and related policy initiatives, by impact category

This annex details the literature review supporting the mapping presented in Section 3.1, by relevant environmental impact:

Climate change: The current food system (production, transport, processing, packaging, storage, retail, consumption, waste management; see Driver 1) is responsible for 30% of greenhouse gas (GHG) emissions in Europe (Crippa et al., 2021).

Farm stages dominate the GHG emissions, representing 61% of the whole food sector's GHG emissions (Poore & Nemecek, 2018). Land use and land use changes (LULUC) associated with agricultural production represent the main GHG emissions source. In 2018 these were estimated to account for 4 Gt CO_2eq year (FAO, 2020), or about 32% of the total food-system emissions (Crippa et al., 2021). Deforestation and land degradation are the main drivers of LULUC climate change through emission of GHGs and reduced rates of carbon uptake (FAO, 2020; Olsson et al., 2019).

The food system has become more and more energy intensive. GHG emissions derived from the production and use of energy and fuels required along the whole supply chain represent the second cause of GHG emission in industrialised as well as in developing countries (Crippa et al., 2021). A significant share of energy is required at farm level, especially for fertilisers manufacturing, use of machinery and irrigation. Food packaging, retail and supermarkets are also energy intensive processes within the food supply chain (EEA, 2019; Notarnicola et al., 2017), as well as food processing industry and households, which represent 30% and 20% of total food systems' energy emissions, respectively (UNEP, 2022). Food transportation has been estimated to account between 5% and 11% of the total emissions from energy in the global food systems (Poore & Nemecek, 2018; Tubiello et al., 2022). However, when the relevant international and domestic transport distances and commodity masses used by the global food sector are accounted for, transportation account for almost the 20% of the total food-system carbon footprint (Li et al., 2022).

Another important climate change driver is represented by non-CO_2 GHG emissions sources. Although since 1990 non-CO_2 GHG emissions from agriculture have declined, agriculture remains the largest contributor to total EU non-CO_2 GHG emissions (EEA, 2019). Agricultural non-CO_2 emissions are constituted mainly by methane (CH_4) and nitrous oxide (N_2O). Enteric fermentation of ruminant livestock is the major source of methane emissions, which make up the largest share (38 %) of all GHG emissions in the sector. Nitrous oxide generating from the use of fertilisers (both synthetic and organic) represented 25 per cent of total agricultural emissions in 2019 (FAO, 2020).

Although methane emissions from enteric fermentations and nitrogen emissions from fertilizers have decreased in Europe in the last decades, global emissions continued to grow after 2010 (FAO, 2020; UNEP, 2022).

The food sector contributes to climate change, but it is also vulnerable to climate change. Changes in CO2 concentration, temperature and precipitation patterns as well as weather and climate extremes are already influencing crop yields and livestock productivity in Europe (EEA, 2019). Climate change may favour the productivity of certain crops, being longer growing seasons and more suitable crop conditions in certain world areas. However, the number of extreme climate events is expected to increase, accelerating land degradation, altering water availability and quality (Bezner Kerr et al., 2022), inducing land use changes and biodiversity loss (EEA, 2019), with consequent negative impacts on food quality and production stability (Ebi & Loladze, 2019; Rama et al., 2022). Climate change affects oceans, marine and freshwater systems as well. Ocean warming has decreased sustainable yields of some wild fish populations and has already affected farmed aquatic species (Rama et al., 2022).

Nevertheless, the agricultural sector may contribute mitigating climate change, through the removal of CO_2 from the atmosphere by implementing adaptation strategies that increase carbon sequestration and storage, such as cover crops, crops diversification and rotation, minimum or no tillage, increased irrigation efficiency, organic and precision farming, improved grassland and pastures (EEA, 2019).

Ozone depletion: As widely recognised in the literature, the main compounds causing significant ozone depletion are represented by refrigerants, including chlorofluorocarbons (CFCs), carbon tetrachloride, methyl chloroform, halons, hydrochlorofluorocarbons (HCFCs), hydrobromofluorocarbons (HBFCs) (EEA, 2016), which are strictly regulated by international[82] and European[83] measures. Another important compound is methyl bromide. Although banned in European countries as agricultural pesticides, it is still used throughout the developing world, especially as a fumigant to control pests in soils, structures and commodities (EEA, 2016).

Other anthropogenic factors affecting the ozone layer are constituted by certain GHG emissions, such as methane and nitrous oxide (Ravishankara et al., 2009). Nitrous oxide (N_2O) is nowadays considered as the dominant ozone-depleting substance (Portmann et al., 2012; Ravishankara et al., 2009). In agriculture, this gas results from nitrogen surplus on farm, especially deriving from application of nitrogen-fertilisers (Meier et al., 2015; Tuomisto et al., 2012). Therefore, interventions in decreasing the use of fertilisers and ameliorating fertilisation practices by increasing their efficiency may favour a reduction of N_2O emissions, and thus a reduction of ozone depletion at primary production stage of the food supply chain.

Land use: The food system is recognised to be one of the major drivers of land use and land use changes worldwide (Poore & Nemecek, 2018; Willett et al., 2019). Almost half of all habitable land is used for agriculture (Ritchie & Roser, 2022) which is among the dominant sectors driving land degradation due to land use changes and unsustainable land management practices (Olsson et al., 2019). Indeed, farmland expansion, driven by the necessity of higher production, have caused land use changes, converting different ecosystems areas to agricultural land. Over the period 2011-2015, almost 30% of the deforestation (e.g. long-term permanent conversion of forest to non-forest land uses) occurring at global scale was attributed to commodity production (including palm oil, soybean and cattle grazing), and shifting agriculture was estimated to cause 24% of global forest disturbance (Curtis et al., 2018). Livestock production is an important driver of deforestation due to the rapid expansion of pastures but also to the increasing demand for high-quality protein feeds, such as soybean. It has been estimated that, in South America, livestock is responsible for more than 85% of deforestation (71% for grazing and 14% for animal feed)(Bonnet et al., 2020).

Unsustainable farming practices may provoke land degradation, including soil erosion, compaction, salinisation and soil organic carbon and nutrient losses (Olsson et al., 2019; van der Werf et al., 2020), deteriorating in such way the overall soil quality and fertility. Contrarily, sustainable practices may reverse land degradation (Olsson et al., 2019). Indeed, preferring organic fertilisers, green manure, intercropping, no or reduced tillage, agroforestry, livestock integration and other sustainable practices often applied under organic and agroecological agriculture, it has been demonstrated to favour soil fertility and quality (Gomiero et al., 2011; Wezel et al., 2014). These practices moreover may also increase the carbon stock of soils, acting as soil carbon storage, influencing positively GHG emissions at farm level (EEA, 2019; Olsson et al., 2019; Wezel et al., 2014). Nonetheless, under large-scale implementation of organic or agroecological food production, the land requirement for agriculture would increase, due to the lower yields obtainable from organic systems in comparison

[82] The first international agreement aimed at protecting the ozone layer was the Vienna Convention (1985). The Montreal Protocol of 1987 (and subsequent Amendments and Adjustments) aims to eliminate the production and use of ozone-depleting substances worldwide (EEA, 2022).

[83] EU measures and policies to protect the ozone layer include the Regulation (EC) No 1005/2009 on substances that deplete the ozone layer lays down rules on the production, use, trade, recovery, recycling, reclamation and destruction of ODS and sets out requirements and measures for products and equipment containing these substances. On 5 April 2022, the European Commission put forward a legislative proposal to replace it (European parliament 2022, https//www.europarl.europa.eu/thinktank/en/document/EPRS_BRI(2022)738195)

with conventional systems (Röös et al., 2022). However, it has been demonstrated that if combined with a reduction in food waste and shifts to plant-based diets (allowing a reduction in farmed animals and feed crop production), organic agriculture could contribute to feeding more than 9 billion people in 2050 (Benton et al., 2021).

Water use: Food systems are nowadays incredibly resource intensive, also concerning water use (Poore & Nemecek, 2018). It has been estimated that almost 70% of global freshwater is withdrawn for irrigation and livestock production (Foley et al., 2011; WWAP UNESCO World Water Assessment Programme, 2019). Irrigation is performed only on 20% of the global arable land, producing 40% of the global food production. More efficient irrigation practices and wastewater treatments are key to increasing the resilience of food systems (Mohtar & Fares, 2022). The remaining production relies on water-fed, which faces growing water risk due to climate change and water use competitions. Indeed, in many regions, agriculture is increasingly subject to extreme weather events (such as droughts, floods, storms, and sea-level rise), which translates into significant yields decline (Gruère et al., 2020). Furthermore, these risks are exacerbated by the growing competition for water from energy, industry or domestic use in urban areas (Gruère et al., 2020).

Almost all animal-based products have a higher water footprint than plant-based products (Watts et al., 2016), since livestock systems use water for feedstock cultivation, but also for drinking and animal servicing, stable washing and cooling, as well as for the maintenance and operation of slaughterhouses and processing plants (Steinfeld et al., 2006).

Food processing is estimated to consume 20% of all extracted fresh water (FAO, 2012).

Eutrophication: Eutrophication is defined as the excessive plant and algal growth in waterbodies due to the increased availability of one or more limiting growth factors needed for photosynthesis (Schindler, 2006), such as sunlight, carbon dioxide, and nutrient fertilizers. Food systems, besides being a major responsible for water consumption, also concur in polluting aquatic ecosystems through both point-source discharges and non-point loadings of limiting nutrients, especially nitrogen and phosphorus compounds and organic matter (Mateo-Sagasta et al., 2017; Ringler et al., 2022).

Primary production is the main responsible of eutrophication along the entire food supply chain (Notarnicola et al., 2017).

In crops cultivation, eutrophication generally occurs when fertilizers are applied at a greater rate than they are fixed by soil particles or exported from soil profiles (Mateo-Sagasta et al., 2017). A recent systematic review of life cycle assessment (LCA) studies comparing organic and conventional cropping systems by (Boschiero et al., 2023) reveals that organic crop systems present lower eutrophication impacts, irrespectively by lower yields.

Livestock husbandry also plays a key role in generating eutrophication. Although organic fertilisers (i.e. manure) have positive impacts on soil fertility and soil biodiversity, a high concentration of livestock in a given zone risks to eliminate these positive impacts by generating an excess of nutrients and thus leading to water pollution (Bonnet et al., 2020). In extensive livestock production systems, usually a diffuse water pollution takes place, due to natural manure or slurry fertilisation of pastures and grazing areas. In intensive systems the associated production of waste tends to go beyond the buffering capacity of surrounding ecosystems, thereby polluting surface waters and groundwater (Mateo-Sagasta et al., 2017).

Fish excreta and uneaten feeds from fed aquaculture diminish water quality and concur to eutrophication, even though this is much lower than the agriculture-related contribution (Mateo-Sagasta et al., 2017).

Ecotoxicity: Worldwide, pesticide use increased from 1.5 to 2.6 kg active ingredient per ha of cropland from 1990 to 2015 (van der Werf et al., 2020). If agrochemicals undoubtedly permitted an intensification of production and increased yields, to the other side they are recognized as a major cause of environmental burdens and impacts, such as ecotoxicity (UNEP, 2016a).

It is demonstrated that generally organic production presents a lower ecotoxicity impact compared to conventional crop systems (Boschiero et al., 2023), although relying on copper-based agrochemicals.

Beside crop production, also animal farming and aquaculture are responsible for ecotoxicity impacts, with emissions of nutrients, hormones, antibiotics and heavy metals to the environment (Du & Liu, 2012; UNEP, 2016a; Watts et al., 2016).

In 2020, with food representing around 45% of the environmental impacts of EU consumption, the EU food system alone transgresses several planetary boundaries, including freshwater ecotoxicity (5 times) (EC-JRC, 2022a; Sala & Sanyé Mengual, 2022).

Resources minerals and metals: Food systems heavily rely on metals and minerals. Primary production uses minerals and metals as source of fertilisers and pesticides (UNEP, 2016a). Conventional systems use significant amount of phosphorous (P) and potassium (K) which represent fundamental fertilisers for crop production Organic cultivation, which is one of the most restrictive standards in terms of pesticides and fertilisers use, although forbidding synthetic fertilisers and pesticides, allows sulphur and copper and sulphur-based compounds, which are extensively used, especially as pesticides (Tamm et al., 2022).

Packaging is another step of the food supply chain that consumes metals (Notarnicola et al., 2017), such as aluminium, iron, tin and bauxite. For instance, about 17% of aluminium in Europe is used in packaging (UNEP, 2016a). The metals used in building the infrastructures and machineries used during food processing, transport, storage and waste treatment should also be considered, however they are of minor extent (UNEP, 2016a).

Particulate matter: In 2020, the EU food system alone transgresses several planetary boundaries, including particulate matter (6 times) (EC-JRC, 2022a; Sala & Sanyé Mengual, 2022). Food systems contribute to particulate matter (PM) formation in several ways. Road transportation and energy consumption required along the whole food supply chain represent the principal source of coarse (PM_{10}) and fine ($PM_{2.5}$) particulate matter (EEA, 2021).

Other emissions of PM_{10} arise from farm-level operations, such as soil tillage and crop harvesting, and from burning crop residues and, to a lesser extent, grasslands (EEA). Primary $PM_{2.5}$ caused by the agricultural sector largely derives from dust from tillage, livestock dust, field burning, and fuel combustion in agricultural equipment use (Domingo et al., 2021).

Biodiversity loss: The most important drivers of biodiversity loss are: habitat changes, climate change, pollution, invasive alien species and overexploitation (Crenna et al., 2019; Millennium Ecosystem Assessment, 2005; Steinfeld et al., 2006).

The global food system plays a key role in decreasing biodiversity (Benton et al., 2021), as it contributes directly or indirectly to all these drivers, at the local and global scale.

Land use changes caused by the conversion of natural land to agricultural land result in habitat changes and destruction (Benton et al., 2021). Crop and animal farming has been behind much of these changes (Steinfeld et al., 2006), due to deforestation caused by the rapid expansion of pastures but also to the increasing demand for high-quality protein feeds, such as soybean or the cultivation of certain plant commodities (e.g. oil palm).

Agriculture contributes to climate change and causes the release of nutrients and pollutants, as described above. Pesticides are indeed recognized as a major driver of biodiversity loss in both terrestrial and aquatic ecosystems (van der Werf et al., 2020). The food sector also directly affects biodiversity through invasive alien species and overexploitation, for example through overgrazing of pasture plants (Steinfeld et al., 2006) or overfishing of natural stocks.

However, certain sustainable farming practices, often applied in agroecological and organic systems, such as diversification of crops species and animal breeds, use of old cultivars, ecological structures (e.g. hedgerows, herbaceous strips, woodlot preservation) may promote biodiversity conservation (Gomiero et al., 2011; Jeanneret et al., 2021; van der Werf et al., 2020). Nevertheless, some authors argue that, due to the lower yield of such systems, a large-scale conversion to sustainable agriculture would require converting more natural habitats for agricultural production, negatively affecting biodiversity conservation (Clark & Tilman, 2017). Major improvements on biodiversity may be reached only when a conjunction of actions is implemented, including sustainable farming techniques, drastic dietary changes, food loss and food waste reduction, expansion and increase of protected areas in key biodiversity areas, minimising agricultural expansion into species rich areas and increasing international trade from high yielding nations with low biodiversity to low yielding nations with high biodiversity (Röös et al., 2022; Willett et al., 2019a).

Waste generation: Waste generation is increasing in the EU with an increase in total waste generation of 5.0% between 2010 and 2018 (114 million tonnes) (EEA, 2022). Agriculture, forestry and fishing accounted in 2016 for around 20% of the total share of waste (EEA, 2018). Although not the major cause of waste production, the food system produces large volumes of wastes, generated from the production, preparation, packaging and consumption of food.

The packaging sector seems to contribute significantly to waste generation. Over the 2009–2020 period, the generation of all types of packaging waste material increased by about 20% (Eurostat, 2022c) . Paper and cardboard were the main packaging waste material in the EU (32.7 million tonnes in 2020) followed by plastic and glass (15.5 million tonnes for plastic and 15.1 million tonnes for glass waste materials in 2020) (Eurostat, 2022c).

Food and beverage packaging accounts for almost two-thirds of total packaging waste by volume and approximately 50% of total packaging sales by weight (Marsh & Bugusu, 2007), and it is estimated to represent two- thirds of total European packaging in terms of market share value (EC, 2019b). Materials that have traditionally been used in food packaging include glass, metals (e.g., aluminium, tinplate, and tin-free steel), paper and paperboards, and plastics (Marsh & Bugusu, 2007).

The packaging sector is the biggest user of plastics (around 40%) and plastic packaging is responsible for around 60% of post-consumer plastic waste in the EU, most of which is only used once and then discarded (European Plastics Strategy, 2018). While plastics production is growing, the recycling of plastics is still low. Less than a fifth of plastic packaging waste is recycled globally and a lot ends up in the environment, is incinerated or landfilled (Heinrich Böll Foundation, 2019). In the EU 28+2, only 41,9% of the 16,7 tonnes of plastic packaging waste was recycled (Eurostat, 2022c).

It has been estimated that in 2018, in the European Union 28+2 countries, the agricultural sector used approximately 1 million tonnes of plastics for packaging purposes (FAO, 2021). This figure may be underestimated, since data were not available for usage in storage, processing, and distribution.

Food waste generation: Estimates for the EU indicate that around 88 million tonnes of food are being wasted yearly across the food supply chain, roughly corresponding to 9% of the total food produced in the EU (De Laurentiis et al., 2021; European Commission & Eurostat, 2022). Food waste occurs along the whole food supply chain, from food production to consumption. However, the consumption stage is identified as the major contributor to the total amount of food waste generated along the food supply chain (De Laurentiis et al., 2021; Stenmarck et al., 2016). Households, retail and food services are estimated to produce altogether 931 million tonnes of food waste per year at a global level (UNEP, 2021), being households the larger food waste producers (79 kg/year), followed by food services (26 kg/year) and retail activities (13 kg/year).

Household food waste can occur throughout the household management stages, including purchasing, storing, preparing, and consuming (Vittuari et al., 2022).

Food processing and manufacturing are responsible for a lower share of food waste, especially concerning fruits, vegetables, cereals, meat and dairy products (De Laurentiis et al., 2021).

Causes of food losses and waste differ based on supply chain stage and geographical setting. Among the drivers, (Canali et al., 2014) highlighted 271 drivers of food waste generation per food supply chain segment and context category; while the study of (Vittuari et al., 2022) provides a literature review of food waste prevention drivers and levers at consumer level.

Waste in primary production can depend on technological inadequacies in harvesting and post-harvest management, caused by lack of appropriate infrastructure and equipment. Inefficiencies can affect operations throughout the supply chain: suboptimal management during food processing and cold chain logistics can aggravate waste production. Other managerial shortcomings, such as imprecise matching between supply and demand/forecasting, together with poor control over inventory and corporate policies on product aesthetics are indicated as leading causes of wholesale and retail waste. Faulty communication and lack of cooperation between supply chain actors can exacerbate operation failures (Canali et al., 2014; FAO, 2019).

Biotic resource (overexploitation): Since biotic resources are limited, it has been widely recognized that a transition to a sustainable exploitation of such resources is necessary (Lampert, 2019), exploiting them at a rate that permits their natural reproduction or regeneration capability.

Overfishing is still widespread across the pan-European region. Globally, the share of overfished fish stocks (meaning that fishes are catch at a rate faster than the natural fish reproduction rate to sustain population levels) has more than doubled since the 1980s (Ritchie & Roser, 2022) leading to unsustainable biotic resource depletion. In 2017, one third (34%) of the of global fish stocks was overfished (Ritchie & Roser, 2022). According to the EU blue economy 2022 (EC, 2022), the situation of wild populations depends on the geographical area. In the North-east Atlantic Ocean and Baltic Sea, 28% of assessed fish and shellfish stocks are within safe biological limits, meaning that the number of stocks within safe biological limits has experienced a 3.5-fold increase, from 8 in 2003 to 28 in 2020. In contrast, 87% of the assessed stocks were overfished in the Mediterranean and Black Seas.

Livestock and aquaculture play an important role in the overall pressure on demand for fish (Ritchie & Roser, 2022; Steinfeld et al., 2006), being the 16% of world fishery production used for fishmeal and fish oil for feeds in 2017 (Naylor et al., 2021). Approximately 17% of the fishmeal produced in the world is manufactured from trimmings from food fish processing, having an indirect impact on fish stocks. However, the remaining 83% come from direct marine capture fisheries (Steinfeld et al., 2006).

Annex 2. List of official national, regional and local websites and reports on GPP

This annex details the data sources used to extract data on current GPP uptake among EU Member States (Table A2.1).

Table A2.1. Data sources of GPP implementation, by country.

Country	Organization	Website
Austria	naBe Platform: Austrian Sustainable Procurement Platform Ökokauf Wien: programme for sustainable procurement website	naBe - Aktionsplan für eine nachhaltige öffentliche Beschaffung ÖkoKauf Wien - programme for sustainable public procurement
Belgium	Federal Institute for Sustainable Development: Information on GPP and criteria Environment Brussels Government of Flanders Circular Flanders	https://news.belgium.be/en/federal-institute-sustainable-development https://environment.brussels/ Duurzame overheidsopdrachten | Vlaanderen Intern https://vlaanderen-circulair.be/en
Bulgaria	АДМИНИСТРАТИВЕН АДРЕС НА МОСВ - Ministry of Environment and Development information on GPP website	Обща информация за "зелените" обществени поръчки - Зелени обществени поръчки - Зелени възможности - Министерство | МОСВ (government.bg)
Croatia	Ministry of Environmental and Nature Protection	Naslovnica - ZeJN - Zelena javna nabava (zelenanabava.hr)
Cyprus	Ministry of Agriculture, Rural Development and the Environment website	Mission - Υπουργείο Γεωργίας, Αγροτικής Ανάπτυξης και Περιβάλλοντος (moa.gov.cy)
Czech Republic	Ministry of Labour and Social Affairs – socially responsible public procurement website	Socially Responsible Public Procurement | SOVZ
Denmark	Ministry of Environment's Forum for Bæredygtige Indkøb Miljøstyrelsen - Environmental Protection Agency	https://denansvarligeindkober.dk/forum https://www2.mst.dk/Udgiv/publikationer/2016/01/978-87-93435-20-9.pdf
Estonia	Ministry of the Environment and Environmental Investment centre	Green Public Procurement | Ringmajandus (envir.ee)
Finland	KEINO Competence Centre for Sustainable and Innovative Public procurement website SYKE Finlands miljöcentral - Finnish Environment Institute Miljöförvaltningens gemensamma webbtjänst	About KEINO | Hankintakeino.fi Suomen ympäristökeskus (syke.fi) https://www.ymparisto.fi/fi
France	Agence de l'Environnement et de la Maitrise de l'Energie ADEME - French Environmental Protection Agency	Accueil - Agence de la transition écologique (ademe.fr)

	Ministère de l'Économie - French Ministry of Economy responsible public procurement My Canteen: Supporting collective catering players to offer quality, healthy and sustainable food	Statistiques ma cantine · Metabase (ma-cantine-metabase.cleverapps.io)
Germany	Umweltfreundliche Beschaffung - Green Public Procurement	https://www.umweltbundesamt.de/themen/uba-erklaerfilm-umweltfreundliche-oeffentliche
Greece	Εθνικό Σύστημα Ηλεκτρονικών Δημοσίων Συμβάσεων (ΕΣΗΔΗΣ) - National System of Electronic Public Procurement	Front Page (eprocurement.gov.gr)
Hungary	Hungarian Public Procurement Authority	Nyitólap - Főportál (kozbeszerzes.hu)
Ireland	Office of Government Procurement Green Tenders - an Action Plan on Green Public Procurement From Department of the Environment, Climate and Communications	https://www.epa.ie/publications/circular-economy/resources/green-public-procurement.php https://www.gov.ie/en/publication/74075-green-tenders-an-action-plan-on-green-public-procurement/
Italy	Ministero della Transizione Ecologica - Italian Ministry of Ecological Transition Information on GPP Gazzetta Ufficiale della Repubblica Italiana, Decreto 10 marzo 2020	| Ministero dell'Ambiente e della Sicurezza Energetica (mase.gov.it) Gazzetta Ufficiale
Latvia	Ministry of Environmental Protection and Regional Development information on GPP Green Public Procurement Support Plan 2015- 2017	Green public procurement | Vides aizsardzības un reģionālās attīstības ministrija (varam.gov.lv) https://faolex.fao.org/docs/pdf/lat190900ENG.pdf
Lithuania	Viešųjų pirkimų tarnyba - Public Procurement Office	https://vpt.lrv.lt/lt/darnieji-pirkimai
Luxembourg	Ministry of Environment, Climate and Sustainable Development	https://mecdd.gouvernement.lu/en.html
Malta	Minister for Sustainable Development, the Environment and Climate Change Information on Green Public Procurement	https://environment.gov.mt/en/decc/Documents/environment/ https://meae.gov.mt/mt/Public_Consultations/MSDEC/Documents/Green%20Public%20Procurement%20National%20Action%20Plan.pdf
The Netherlands	PIANOo – Dutch Public Procurement Expertise Centre Information on Sustainable Public Procurement	https://www.pianoo.nl/en MVI-criteriatool (mvicriteria.nl)

Poland	Urząd Zamówień Publicznych - Public Procurement Office Information on SPP	Zrównoważone zamówienia publiczne - Urząd Zamówień Publicznych (uzp.gov.pl)
Portugal	APA Agência Portuguesa do Ambiente - Portuguese Environment Agency National Strategy for GPP	https://encpe.apambiente.pt/
Romania	Agenția Națională pentru Achiziții Publice - National Agency for Public Procurement	Ghid de Achiziții Publice administrat de ANAP (gov.ro)
Slovakia	Slovak Environment Ministry Enviroportal Information on voluntary environmental policy instruments including GPP	Dobrovoľné nástroje environmentálnej politiky - Enviroportál - životné prostredie online (enviroportal.sk)
Slovenia	Direktorat za javno naročanje - Directorate for Public Procurement Information on GPP	http://www.djn.mju.gov.si/english https://www.care4climate.si/_files/1797/Analiza-ZeJN_4-0_final.pdf
Spain	Public Procurement Observatory	https://www.obcp.es/
Sweden	Upphandlingsmyndigheten – The National Agency of Public Procurement SPP	https://www.upphandlingsmyndigheten.se/en/

Source: Own elaboration

Annex 3. Consumption Footprint Food: list of representative food products

This annex enlists the representative products included in the Consumption Footprint – Food model used in this study to assess the potential effect on environmental impacts of specific examples (Table A3.1).

Table A3.1. Representative products of the Consumption Footprint – Food model, by product group.

	Product group	**Representative Product**	**Product group**	**Representative product**
FOOD	MEAT	Pork meat	BEVERAGES	Beer
		Beef meat		Wine
		Poultry meat		Mineral water
	FISH & SEAFOOD	Salmon	CONFECTIONERY PRODUCTS	Biscuits
		Cod		Chocolate
		Shrimps	TUBERS	Potatoes
		Tuna	FRUITS	Apples
	DAIRY	Milk		Oranges
		Cheese		Bananas
		Butter		Avocados
	EGGS	Eggs		Strawberries
	CEREAL-BASED PRODUCTS	Bread	NUTS & SEEDS	Almonds
		Pasta		Cashew
		Rice	COFFEE & TEA	Coffee
		Quinoa		Tea
	SUGAR	Sugar	VEGETABLES	Tomatoes
	OILS	Sunflower oil		Broccoli
		Olive oil		Carrots
		Rapeseed oil	LEGUMES	Beans
		Soybean oil		Chickpeas
		Palm oil		Lentils
	LEGUME PRODUCTS	Tofu	PRE-PREPARED MEALS	Meat-based dishes
		Soy drink		

Source: Sanyé Mengual and Sala, (2023).

Annex 4. Impact categories, unit and underpinning models of the Environmental Footprint method

Table A4.1 includes the impact categories of the Environmental Footprint method used in this study, including the unit of measurement and the impact assessment model underpinning the calculations.

Table A4.1. Impact category, unit, and impact assessment model of Environmental Footprint method.

Impact category	**Unit**	**Model adopted as in EF (and indication of Model robustness[a])**
Climate change (GWP)	kg CO_2 eq.	Bern model - Global warming potentials (GWP) over a 100-year time horizon (based on (IPCC 2013) (I)
Ozone depletion (ODP)	kg CFC-11 eq.	EDIP model based on the ODPs of the World Meteorological Organisation (WMO) over an infinite time horizon (WMO 2014 + integrations) (I)
Particulate matter (PMFP)	Disease Incidence	PM model in (UNEP 2016b) (I)
Ionising radiation (IRP)	kBq U-235 eq.	Human health effect model as developed by (Dreicer et al., 1995, Frischknecht et al., 2000) (II)
Photochemical ozone formation (POF)	kg NMVOC eq.	LOTOS-EUROS model (van Zelm et al., 2008) as applied in ReCiPe 2008 (II)
Acidification (AP)	mol H^+ eq.	Accumulated exceedance (Seppälä et al., 2006), (Posch et al., 2008) (II)
Eutrophication, terrestrial (TEP)	mol N eq.	
Eutrophication, freshwater (FEP)	kg P eq.	EUTREND model (Struijs et al., 2009) as applied in ReCiPe (II)
Eutrophication, marine (MEP)	kg N eq.	
Freshwater ecotoxicity (FETP)	CTUe	based on USEtox2.1 model (Fantke et al., 2017), adapted as in Saouter et al., 2018 (III)
Human toxicity, non-cancer (HTPnc)	CTUh	
Human toxicity, cancer (HTPc)	CTUh	
Land use (LUC)	Pt	Soil quality index based on LANCA model (De Laurentiis et al., 2019) and on the LANCA CF version 2.5 (Horn and Maier, 2018) (III)
Water use (WRD)	m^3 water eq.	Available WAter REmaining (AWARE) model (Boulay et al., 2018); (UNEP 2016b) (III)
Resource use, fossils (FRD)	MJ	ADP fossils (van Oers et al., 2002) (III)
Resource use, minerals and metals (MRD)	kg Sb eq.	ADP ultimate reserve (van Oers et al., 2002) (III)

[a] Model robustness as indicated in the Environmental Footprint recommendation (EC, 2021b);

Source: Adapted from Sanyé Mengual & Sala, (2023).

Annex 5. Coverage of environmental impacts and life cycle stages by GPP criteria

Table A5.1 provides a concise mapping of GPP criteria, environmental impact categories and main life cycle stages involved.

Table A5.1. Mapping between GPP criteria, environmental impacts and life cycle stages of food products, by product group and criteria category.

Product group	Criteria category	GPP criteria	Main environmental impact categories involved	Life Cycle Stage
Food procurement	Technical specifications	Organic food products	Land use Biodiversity loss Ecotoxicity Climate change Eutrophication Resource minerals and metals	Primary production
		Marine and aquaculture food product	Biotic resources Biodiversity	Primary production
		Animal welfare	Animal welfare	Primary production
		More environmentally responsible vegetable fats	Land use Biodiversity loss	Primary production
	Award criteria	Additional organic food products	Land use Biodiversity loss Ecotoxicity Climate change Eutrophication Resource minerals and metals	Primary production
		Additional marine and aquaculture food products	Biotic resources Biodiversity	Primary production
		Additional animal welfare	Animal welfare	Primary production
		Fair and ethical trade products	Land use Biodiversity loss	Primary production
	Contract performance clauses	Procurement management practices	-	-
Catering services	Technical specifications	Food procurement	See the Product group	Primary production
		Plant-based menus	Climate change Land use Water use Eutrophication Ecotoxicity	Consumption
		Food and beverage waste prevention	Food waste	Consumption
		Other waste: prevention, sorting and disposal	Waste generation	Consumption End of life Packaging
		Chemical products and consumable goods	Waste generation	Consumption
		Energy and water consumption in the kitchens	Ozone depletion Climate change Water use	Consumption
		Food transportation	Particulate matter Climate change	Distribution
		Environmental management measures and practices	-	-
	Award criteria	Chemical products and consumable goods	Waste generation	Consumption
		Energy and water consumption in the kitchens	Ozone depletion Climate change Water use	Consumption

		Food transportation (Air pollutant emissions, Greenhouse gas emissions, Refrigerants)	Particulate matter Climate change Ozone depletion	Distribution
	Contract performance clauses	Provision of low impact drinking water	Waste generation	Consumption
		Purchase of new kitchen equipment and vehicles	Ozone depletion Climate change Particulate matter	Consumption Distribution
		Environmental management measures and practices	-	-
		Staff training	-	-
Vending machines	Technical specifications	Organic food products	Land use Biodiversity loss Ecotoxicity Climate change Eutrophication Resource minerals and metals	Primary production
		More environmentally responsible vegetable fats	Land use Biodiversity loss	Primary production
		Smart controls	-	-
		Reusable cups	Waste generation	Consumption
	Award criteria	Additional organic food products	Land use Biodiversity loss Ecotoxicity Climate change Eutrophication Resource minerals and metals	Primary production
		Fair and ethical trade products	Land use Biodiversity loss	Primary production
		Annual energy consumption	Climate change	Consumption
	Contract performance clauses	Purchase of new vending machines	-	-

Source: Own elaboration

Annex 6. Food waste generation in alternative diets: coefficients and detailed results by product group and product

The following tables detail the coefficients used in the calculation of food waste generation (also differentiating between edible and inedible food waste) resulting from current and alternative diets (Table A6.1). The results per product are detailed for EAT-Lancet (Table A6.2) and FBDGs diets (Table A6.3), always providing as reference the current diet.

Table A6.1. Food waste coefficients per kg of food item.

Food product	Total food waste (1) (kg)	Edible food waste (kg) (2)	Inedible food waste (kg) (2)
Poultry	0.50	0.38	0.13
Eggs	0.36	0.31	0.05
Fresh vegetables	0.31	0.25	0.07
Fresh pulses	0.31	0.22	0.09
Fresh potatoes	0.31	0.24	0.07
Fresh fruit	0.28	0.21	0.07
Fish	0.22	0.20	0.02
Nuts	0.20	0.09	0.11
Bread	0.20	0.20	0.00
Pastry	0.20	0.20	0.00
Olive Oil	0.19	0.19	0.00
Rape and Mustard Oil	0.19	0.19	0.00
Soyabean Oil	0.19	0.19	0.00
Sunflower seed Oil	0.19	0.19	0.00
Cottonseed Oil	0.19	0.19	0.00
Palm Oil	0.19	0.19	0.00
Pig	0.18	0.16	0.02
Rice	0.18	0.18	0.00
Pasta	0.18	0.18	0.00
Sheep	0.17	0.13	0.04
Bovine	0.17	0.15	0.03
Sugar beets	0.13	0.13	0.00
Cheese	0.12	0.12	0.00
Olives preserved	0.11	0.09	0.02
Processed fruit	0.11	0.11	0.00
Breakfast cereals	0.10	0.10	0.00
Processed vegetables	0.09	0.08	0.01
Processed potatoes	0.09	0.09	0.00
Other dairy products	0.07	0.07	0.00
Flour	0.06	0.06	0.00
Beer	0.06	0.06	0.00
Milk	0.05	0.05	0.00
Yoghurt	0.05	0.05	0.00
Butter	0.05	0.05	0.00
Biscuits	0.04	0.04	0.00

Source : (1) (De Laurentiis et al., 2021) (2) (De Laurentiis et al., 2023)

Table A6.2. Current EU diet and food waste. EAT-Lancet diet and food waste estimation (kg person^{-1} year^{-1}).

Product group	Food provided per diet		Current EU diet food waste (FW)		EAT-LANCET diet food waste (FW)	
	Current EU diet	**EAT-LANCET**	**Total FW (kg)**	**Edible FW (kg)**	**Total FW (kg)**	**Edible FW (kg)**
Cereals	55.08	101.90	9.91	9.91	18.33	18.33
Milk + Cheese	91.73	59.62	7.14	7.14	4.64	4.64
Eggs	13.64	6.14	4.91	4.27	2.21	1.92
Fish	20.52	21.55	4.58	4.07	4.81	4.27
Fruits	87.14	126.35	24.60	18.21	35.67	26.40
Legumes	3.27	5.89	1.02	0.72	1.84	1.30
Red meat	73.47	16.16	12.78	10.87	2.81	2.39
Poultry	29.77	23.82	14.97	11.23	11.98	8.98
Nuts	4.71	8.95	0.94	0.44	1.79	0.84
Oils	19.69	14.96	3.64	3.64	2.77	2.77
Tubers	92.07	22.10	18.37	15.27	4.41	3.66
Vegetables	109.34	136.68	34.00	26.86	42.50	33.58
Sugar	26.81	8.04	3.57	3.57	1.07	1.07
Butter	3.91	2.54	0.18	0.18	0.12	0.12
TOTAL	**631.15**	554.69	140.61	116.39	134.94	110.28

Source: (EC-JRC, 2022; (Willett et al., 2019)

Table A6.3. FBDGs diet food consumption and food waste estimation (kg person^{-1} year^{-1}).

Product group	Food provided per diet		Current EU diet food waste (FW)		FBDGs diet food waste (FW)	
	Current	**FBDGs**	**TOTAL waste (kg)**	**Edible (kg)**	**TOTAL waste (kg)**	**Edible (kg)**
Cereals + potato	147.15	193.05	28.28	25.18	45.71	40.99
Milk	71.40	153.10	4.68	4.68	8.23	8.23
Eggs	13.64	10.80	4.91	4.27	6.08	5.29
Fish	20.52	11.90	4.58	4.07	3.42	3.04
Fruits	87.14	101.10	24.60	18.21	39.77	29.43
Legumes	3.27	17.00	1.02	0.72	7.64	5.42
Red meat	73.47	19.40	12.78	10.87	4.09	3.47
Poultry	29.77	11.30	14.97	11.23	11.44	8.58
Nuts	4.71	8.40	0.94	0.44	2.10	0.99
Oils + butter	23.60	15.00	3.82	3.82	1.97	1.97
Vegetables	109.34	162.90	34.00	26.86	73.53	58.09
Sugar	26.81	17.60	3.57	3.57	2.70	2.70
Cheese	20.33	18.10	2.46	2.46	2.49	2.49
TOTAL	**631.15**	**739.65**	**140.61**	**116.38**	**209.17**	**170.69**

Source: (EC-JRC, 2022; European Commission, 2019)

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